CIGSS Acquisition Handbook
Version 2.0

Volume I Standards

THIRD DRAFT

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EXECUTIVE SUMMARY

One of the primary sources of intelligence for warfighting commanders is imagery acquired by a variety of national, theater, and tactical sources. To satisfy the need of the JTF commander for information, available imagery must be received, processed, exploited, and disseminated in deployable ground- or surface-based systems that are connected to appropriate Command, Control, Communications, Computers, and Intelligence (C4I) nodes.

The Ground/Surface Systems (GSS) comprise a family of specialized, integrated, and deployable systems (e.g., CARS, ETRAC, IDPS, JSIPS, JSIPS-N, MIPE, MIES, PINES, SENIOR BLADE/GAZE, TEG) that have been and are being developed to satisfy the reconnaissance imagery collection, processing, exploitation , and dissemination needs of individual services. The experience of Desert Storm showed that these systems need to become more versatile in order to provide the support that the JTF commander needs under unforeseen operational conditions. Specifically, they need to be interoperable, modular, and scaleable and to migrate to a common architecture.

The Common Imagery Ground/Surface System (CIGSS) is the DARO vision for the objective imagery architecture of future GSS. The CIGSS Joint Operational Requirements Document (JORD) defines CIGSS as a full performance system being capable of supporting the imagery needs of any size and type of JTF. DARO has plotted a course to provide the GSS with a common architecture and common components. The strategy for satisfying the JORD is to migrate the GSS to the CIGSS architecture. Furthermore, the incompatibilities between IMINT and SIGINT ground stations are to disappear by integrating the ground stations of all intelligence disciplines into the Distributed Common Ground/Surface System (DCGSS) architecture.

CIGSS is an architectural model for modular scaleable and interoperable GSS and is included in the following architectures: (1) the DoD Joint Technical Architecture (JTA), (2) NIMA's United States Imagery and Geospatial Data System (USIGS), and (3) DARO's Airborne Reconnaissance Information Technical Architecture (ARITA). Furthermore, the JORD imposes functionality and common components requirements on CIGSS.

CIGSS is defined by its Reference Model which is the intersection of all requirements mandated by the three architectures above and the JORD. It specifies specific standards, architectural constraints, and common components to be used. The sources of all these are approved documents of the three architectures and the JORD that mandate compliance with specific standards and the use of specific common components. These documents are viewed as the "foundation" of CIGSS which is described by its operational architecture and its technical architecture. The operational architecture is defined in terms of functions derived from the CIGSS mission. The technical architecture is the Reference Model.

The CIGSS Acquisition Handbook provides architectural and standards guidance to system developers for the migration of existing GSS or the development of new ones. The Handbook appears in two volumes. Volume I describes the CIGSS operational architecture in terms of functions that should be implemented in compliance with specific standards. Volume II describes the CIGSS Reference Model. DARO is the proponent of the Handbook. Beginning in June 1997, NIMA will be responsible for the maintenance of Volume I, since it is primarily a standards document, but DARO will be responsible for Volume II.

The present document is Volume I of the Handbook. It describes the CIGSS concept of operation and provides overviews of the “foundation” documents and how they affect the CIGSS operational and technical architectures. CIGSS has key interfaces with the following:

1. Imagery collection systems or sources through the Input of Sensor Data and Mission Planning functions.

2. USIGS through the Image Archiving and IMINT Dissemination functions. USIGS documents impact the architecture of CIGSS as an image archiving, exploitation, and dissemination system connected to USIGS.

3. JTA through the External Communications and CIGSS Infrastructure functions. JTA impacts the CIGSS architecture as a DoD information system and mandates compliance with the Defense Information Infrastructure (DII) Common Operating Environment (COE) and connection to the Global Command and Control System (GCCS).

Volume I extracts from the “foundation” documents seven interoperability objectives and four commonality, modularity, and scaleability objectives for the CIGSS architecture and connects them to specific paragraphs of the “foundation” documents. Volume I also assigns standards to each CIGSS function. These are derived from the seven interoperability objectives as well as mandated standards from JTA, DII COE, JORD, and NIMA documents.

1. INTRODUCTION

1.1 Background

The Ground/Surface Systems (GSS) comprise a family of specialized, integrated, and deployable systems (e.g., CARS, ETRAC, IDPS, JSIPS, JSIPS-N, MIPE, MIES, PINES, Senior Blade/Gaze, TEG) that have been and are being developed to satisfy the reconnaissance imagery collection, processing, exploitation, and dissemination needs of individual services. Each existing GSS operates on image data from specific sensors and was not necessarily developed to handle image data from the sensors of another GSS. Also, some of the GSS processors handle imaging data and others handle signals data.

The Common Imagery Ground/Surface System (CIGSS) is the DARO vision for the objective imagery architecture of <u>future</u> GSS. The CIGSS Joint Operational Requirements Document (JORD) defines CIGSS as a full performance system being capable of supporting the imagery needs of any size and type of JTF. In fact, CIGSS is intended to correct the performance shortfalls of the earlier ten GSS.

The Distributed Common Ground/Surface System (DCGSS) is the DARO vision for the migration of SIGINT, IMINT and MASINT ground stations to integrated ground stations. The CIGSS architecture is providing the blueprint for the IMINT part of DCGSS, while the Joint Airborne SIGINT Architecture (JASA) is defining the SIGINT part of DCGSS. IMINT and SIGINT ground stations have many common or similar functions. They need high bandwidth Local Area Networks to connect input data sources to data processors, data libraries and exploitation workstations. They also require information systems functionality to process, store and disseminate the exploitation products. The Airborne Reconnaissance Information Technical Architecture (ARITA) document shows the integration of IMINT, SIGINT and MASINT functions in the ground stations, in its Airborne Reconnaissance Functional Reference Model. The CIGSS architecture facilitates the integration of SIGINT and MASINT ground station functions. The migration to DCGSS will be accomplished in the near future by CIGSS and JASA migration to common ground station Reference Models and standards.

CIGSS is an architectural model for <u>modular scaleable and interoperable</u> GSS, that perform image processing and exploitation functions. CIGSS compliant GSS will provide the warfighter with local and remote access to airborne and national reconnaissance imagery and imagery products. CIGSS is a key element not only of DARO's ARITA, but also of the United States Imagery and Geospatial System (USIGS) and the Intelligence Community strategic plan.

The existing GSS are currently migrating towards the CIGSS architecture, and development agencies/services are required to produce plans within their funding profiles which show schedules to achieve compliance with the CIGSS architecture.

CIGSS is defined by its operational architecture that describes the CIGSS functions and its technical architecture described by the CIGSS Reference Model. The CIGSS architecture is based upon open systems commercial standards and military adaptations of commercial standards selected through the National Imagery and Mapping Agency (NIMA) and the Defense Information Systems Agency (DISA), and other DoD processes. The intent of these standards is to provide functional and performance specifications to guide the component selection and design of ground-based imagery processing and exploitation systems and to ensure interoperability of these systems with each other and with other elements of ARITA and USIGS. Interoperability objectives (see section 2.5) guide the selection of CIGSS standards.

The CIGSS Reference Model implements the standards and in addition applies architectural constraints in terms of core components and interfaces for the purpose of meeting specific commonality and scaleability requirements in the JORD, (see section 2.6).

1.2 CIGSS Mission

The mission of an original GSS was simpler than the CIGSS mission.

The GSS provided the capability to receive and process raw sensor data. Due to weight and space limitations on the airborne platforms, sensors are usually designed so that the data processing operations that are needed to produce images ready for exploitation are accomplished on the ground. Mission planning and mission control were added to the GSS functions in order to plan aircraft flight paths and sensor operations prior to the mission and to monitor and modify the flight paths and/or sensor operations in near-real-time (NRT) during the mission in response to standing and ad-hoc imaging requirements. Some GSS also process and exploit Signals Intelligence (SIGINT) data.

In general, the older generations of GSS were developed by a single service for a single collection platform-sensor suite combination and the GSS architecture and products were tailored for that specific combination. Such GSS were also accomplishing certain specialized functions of interest to that service. These GSS resulted in some problems:

a. Their imagery could not be shared with other services due to specialized formats.

b. Remote access of imagery and products and remote exploitation capability were very limited.

c. The GSS for one suite of sensors could not process raw data from another suite of sensors.

d. Cost savings could not be realized, since GSS functions that were similar across the GSS were being developed independently.

The JORD specifies the performance of CIGSS as a large GSS. Hence, the present section (1.2 CIGSS Mission) describes the mission of a full performance GSS. The JORD also stipulates the CIGSS to be modular with common components to allow scaleability by adding additional components and for the purpose of increasing performance as needed by the JTF. The wording in the JORD also allows subtraction of CIGSS functions and components to result in GSS that are fractional implementations of CIGSS.

Due to DoD interoperability requirements, the CIGSS mission is enlarged by making the imagery and exploitation products accessible to a wide variety of users through the United States Imagery & Geospatial data System (USIGS) architecture. The CIGSS must comply with a set of standards to enable:

a. Remote access of its imagery and products by the general user.
b. Exploitation of its imagery by remote exploitation sites.
c. Introduction and exploitation of imagery from other CIGSS or sensor systems.

The requirements for integration to the USIGS and compliance with the Department of Defense Joint Technical Architecture (JTA), DoD interoperability requirements, and specific standards comprise the additions for the CIGSS mission. Another significant difference in missions is that CIGSS are required to be capable of handling video, Multi-Spectral Imagery (MSI) and Moving Target Indicator (MTI) data as well as the more conventional imagery of airborne sensors. Standards for these capabilities, if not currently approved are not present in this version of the Handbook. They are expected to appear in future versions.

1.3 The CIGSS Acquisition Handbook

The CIGSS Acquisition Handbook, known as CASH in its Version 1.0 was published in July 1995 to provide guidance to GSS developers for the migration of existing GSS or the development of new systems. Due to ensuing developments in the CIGSS architecture core components and new standards, the Version 2.0 of the Handbook was developed. For Version 2.0 there is a minor change to the title of the Handbook from CIGSS Acquisition Standards Handbook to CIGSS Acquisition Handbook to reflect the fact that the Handbook defines not only interoperability standards, but also the CIGSS Reference Model with its core components and their interfaces. The First Draft of Version 2.0 was published on 31 January 1997, and after the receipt of comments on the First Draft, the Second Draft was published on 28 February 1997.

The Second Draft was reviewed by the CIGSS Standards Working Group on 13 March. NIMA and DARO concluded that the Second Draft was not a pure standards document and would not be suitable for approval by standards committees like the Imagery Standards Management Committee (ISMC). It was thus necessary to separate the CIGSS standards from the CIGSS Reference Model, and a decision was made to divide the Handbook into two volumes, one that addresses only standards (Vol. I, the present document) and the other that addresses the CIGSS Reference Model (Vol. II). Volume I describes the CIGSS operational architecture and Volume II the CIGSS technical architecture. The two volumes are complementary and mandated for all imagery GSS included in the Defense Airborne Reconnaissance Program (DARP).

The Handbook (both volumes) is intended to provide architectural and standards guidance to system developers for the migration of existing GSS or the development of new ones. All standards and architectural constraints are derived from official documents of DoD, NIMA, DISA, DARO and JCS.

The Handbook will be a living document.. As the documents on which it is based are modified or updated, the Handbook will be updated also. The question arises whether migrating GSS become instantly non-compliant when a new version of the Handbook is published. The answer is NO, because when and how the current version of the Handbook gets implemented on a specific GSS is a migration issue to be decided by the CIGSS Migration Working Group (CMWG). Each GSS PMO will update its migration plan when a new version of the Handbook is published. The CMWG will review the updated migration plan and establish effectivity dates for specific standards to be complied with. The GSS must comply with the standards in the new version of the Handbook, after the effectivity dates, otherwise, it will be non-compliant.

1.4 Scope of CIGSS Handbook Version 2.0

Version 1.0 of the Handbook focused on achieving basic (Level 1) interoperability, defined as <u>the capability to exchange imagery and imagery products and to collaborate with any other version 1.0 compliant exploitation center</u>. Version 1.0 specified common image file and message formats, data link standards, capability for remote access of USIGS libraries, minimum functionality for exploitation services, and compatibility with selected military networks and input/output hardcopy media.

The Handbook (Version 2.0) has the goal of extending the meaning of interoperability (see Interoperability Objectives in section 2.). The Interoperability Objectives will be met by compliance with the Defense Information Infrastructure (DII) Common Operating Environment (COE), the JTA and the USIGS Common Imagery Interoperability Profile (CIIP).

The Handbook will balance several conflicting needs and trends. Figure 1-1 provides a pictorial description of the needs and trends. There is a need to achieve interoperability, commonality, modularity and scaleability among the various ground systems and with a variety of imagery exploitation facilities that may be tasked to support the exploitation of imagery collected by airborne and national collectors during a military conflict. DARO's solution is the CIGSS Reference Model. NIMA's solution is the USIGS architecture and its standards. Another aspect is the DoD requirement of interoperability with GCCS described in the JTA, and DII COE documentation. Another aspect is the fact that both COTS and GOTS standards are evolving rapidly due to the continuing information systems technology revolution. While this standards evolution will improve interoperability in the long run, it causes difficulties in the GSS migrations to the CIGSS Reference Model, because it causes the standards to be moving targets. Another aspect is the cost of achieving interoperability with existing specialized systems. Yearly funding limitations slow down the migration processes of such systems. To achieve the desired balance between these conflicting needs and trends necessitates the involvement of NIMA and the ground systems' Program Management Offices (PMOs) in the definition and refinement of Vol. I of the Handbook through the CIGSS Standards Working Group (CSWG). Likewise, there is a need for Defense Airborne Reconnaissance community awareness and representation in the NIMA and other DoD processes for the selection of standards.

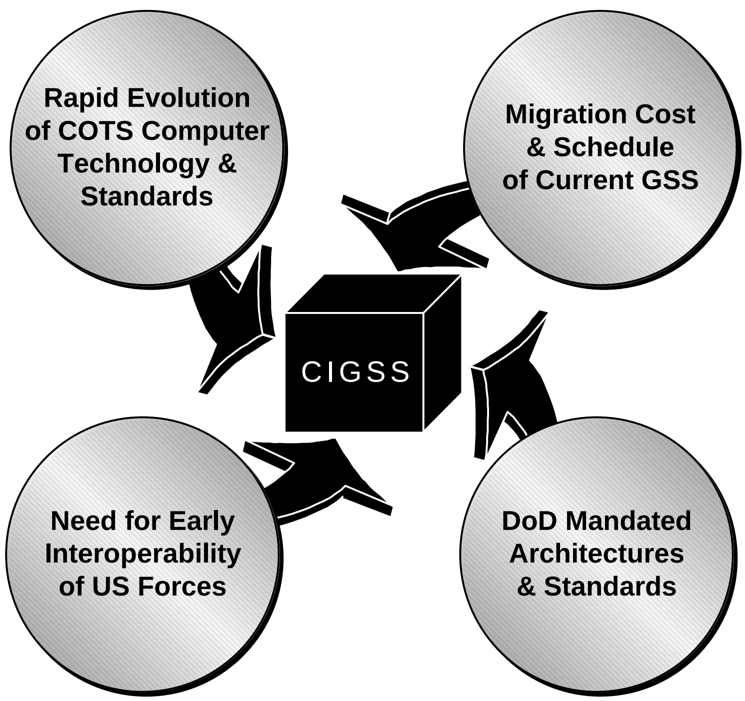

Figure 1-1. CIGSS to Balance Divergent Needs and Trends

1.5 Handbook Development Process

The development process for Version 2.0 of the Handbook (Volume I only) is similar to the process employed in Version 1.0. The CIGSS Standards Working Group, established by DARO has the responsibility to review and approve Version 2.0 of the Handbook and its future modifications. The details of the Handbook development process can be found in the CSWG charter document which is currently available in draft form.

DARO's is the proponent for Version 2.0 of the Handbook and will manage its change processes.

1.6 CIGSS Handbook Organization

The CIGSS Handbook is organized in four main sections.

Section 1. INTRODUCTION provides information on the CIGSS background and its mission in providing finished imagery and imagery derived products and information to the warfighter. This section then proceeds to define the purpose of the CIGSS Handbook and the scope of the Handbook Version 2.0, which will be replacing the current Version 1.0.

Section 2. INTEROPERABILITY OBJECTIVES provides the foundation for the selection of interoperability standards and the derivation of the applicable standards in section 3.

Section 3. CIGSS OPERATIONAL ARCHITECTURE provides an architectural model for CIGSS and defines its baseline functions, and interfaces to external systems. The description of the CIGSS functions in this section is presented from the point of view of achieving open, interoperable systems, so the applicable standards are defined for each CIGSS function and its interfaces.

Section 4. INDEPENDENT VERIFICATION PROCESS defines an independent verification process for ascertaining compliance to the standards. This section provides an overview of the verification process which is defined in detail in the CIGSS Overarching Test and Evaluation Plan document.

The approach in preparing this volume of the Handbook is to focus on the CIGSS functions, and identifying the applicable standards. The rapid evolution of technology and standards introduces a requirement for careful management of changes. Therefore, only approved versions of standards documents will be used. The Handbook will not contain descriptions or tutorials of the standards. The reader will be referred to the appropriate standards documents for that type of information. The standards documents are listed in APPENDIX A - DOCUMENT REFERENCES.

APPENDIX B - ACRONYMS AND DEFINITIONS defines the acronyms used in the Handbook.

2. CIGSS OBJECTIVES

This section is intended to satisfy several purposes:

a. Provide an understanding of the foundation documents from DoD (JTA, DII COE), NIMA (USIGS documents), and DARO (JORD) that define requirements and/or standards for interoperability, commonality, modularity and scaleability.

b. Define the CIGSS interoperability objectives and provide a traceability matrix to the DoD interoperability requirements and the CIGSS JORD. The interoperability objectives are used in Section 3.0 to select the standards to be applied to the CIGSS Functions.

c. Define the CIGSS commonality, modularity and scaleability objectives and provide a traceability matrix to the CIGSS JORD. The combined objectives (interoperability, commonality, modularity and scaleability) are the driving force for the CIGSS definition and development activities (core products and interface definition). The CIGSS architecture has already been fleshed out in substantial technical detail and is described by the CIGSS Reference Model in Vol. II of the Handbook.

d. Define the ground rules under which the CIGSS architecture is to be applied on the various GSS and the meaning of CIGSS compliance. This is presented in section 2.7.

This section provides overviews of:

1. The typical CIGSS concept of operations to assist the reader in understanding the derivation of the CIGSS Functions in Section 3.

2. The Department of Defense interoperability objectives and initiatives which are defined by the Joint Technical Architecture (JTA) and the Defense Information Infrastructure (DII) Common Operating Environment (COE). Both JTA and DII COE are applicable to CIGSS and mandate standards for CIGSS.

3. The USIGS architecture which is being developed by NIMA for the purpose of enabling imagery users to access and use imagery generated by national and tactical sensors, as well as permitting users to access secondary imagery and exploitation products. The underpinnings of the USIGS architecture are a set of open, COTS and GOTS standards, adherence to which promotes interoperability.

4. The CIGSS Joint Operational Requirements Document (JORD) that mandates the required CIGSS capabilities to provide IMINT support to a Joint Task Force.

Section 2.5 derives the CIGSS interoperability objectives from the JORD, JTA and USIGS documents. These objectives are used in Section 3 to define the applicable standards for each CIGSS Function.

Section 2.5 derives the CIGSS commonality, modularity, and scaleability objectives from the JORD.

Section 2.7 provides concepts and definitions on how the CIGSS Reference Model applies to existing and future GSS and the meaning of CIGSS compliance.

2.1 CIGSS Concept of Operations

Section 2.1 describes the concept of operations of CIGSS as an architectural model. The reader is cautioned to not think of CIGSS as a single system. CIGSS-compliant GSS will be a family of real systems each of which will have the capability of performing the operations described. In this section the term <u>CIGSS</u> is used often as an abbreviation for <u>CIGSS compliant GSS</u>. This section is a summary of the CIGSS Concept of Operations document.

Figure 2-1 shows a simplified diagram of CIGSS. It is assumed that in general a CIGSS would be deployed in a theater of operations or a territory near a theater of operations and would support the imagery and imagery derived information needs of Theater, Joint Task Force (JTF), and/or components during a Major Regional Conflict (MRC), a Lesser Regional Conflict (LRC), or Operations Other Than War (OOTW). The CIGSS could be a Theater or JTF or Corps level asset and would receive tasking directly from the J-2 or indirectly through a service component of the JTF. Comprised of modular functional components, CIGSS deployments may be tailored to meet specific operational requirements. Depending upon the individual Service's employment concept, a CIGSS may be contained in ruggedized shelters, carried on board High Mobility Multipurpose Wheeled Vehicles (HMMWVs), or installed in aircraft carriers. CIGSS are deployable to the field by air, sea, or surface transportation. Of course CIGSS could also be employed in fixed facilities, depending on operational needs.

It should be noted that a CIGSS compliant GSS may have specialized functions and capabilities in addition to the baseline functions and "core" components of CIGSS as defined by the JORD. The current concept of operations section discusses only the operations of the CIGSS baseline functions. Specialized functions or components will not appear in the discussion of operations and should not be viewed as being excluded. The functionality provided by the baseline CIGSS is described in the following sections from the point of view of its mission and operations.

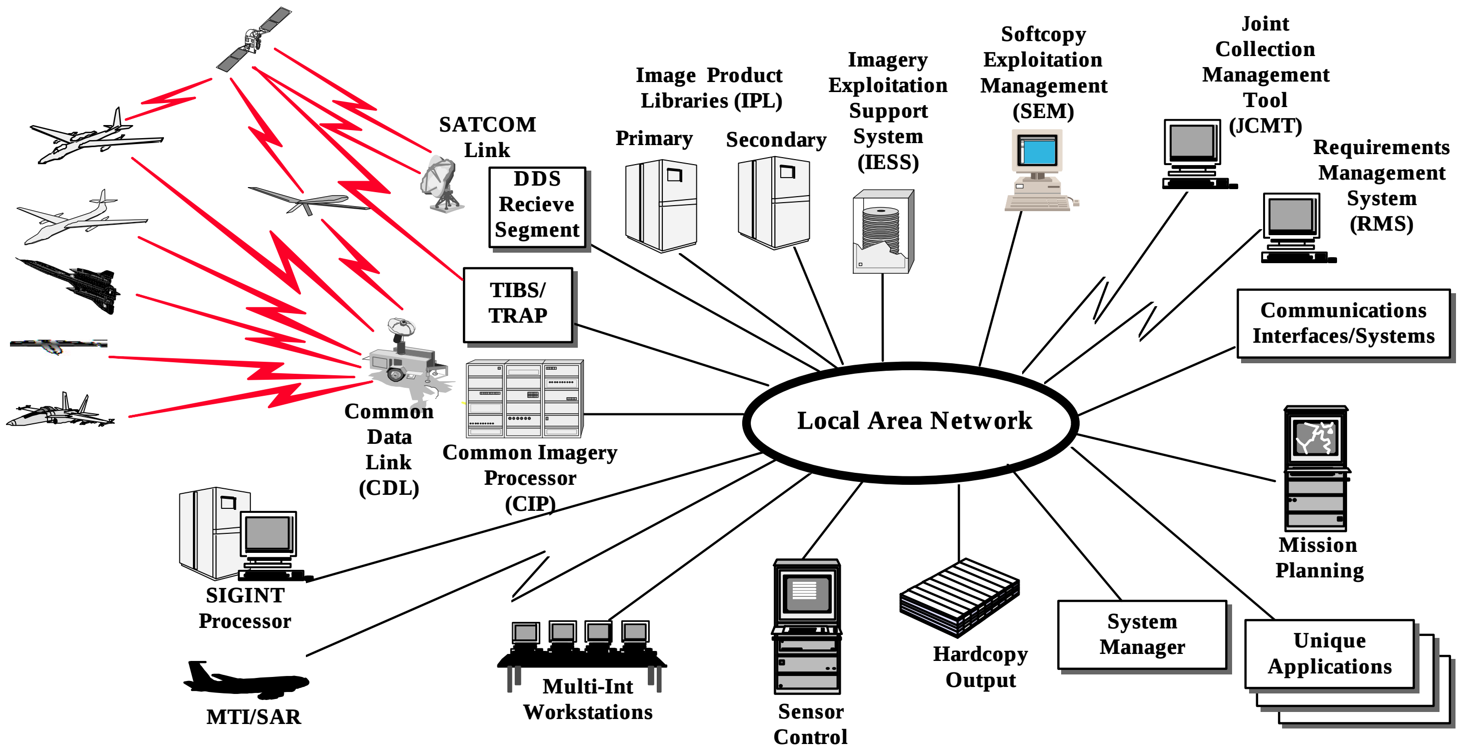

Figure 2-1. CIGSS Components

2.1.1 Tasking

Imagery intelligence requirements flow into and from CIGSS consistent with the infrastructure of the supported user. The Requirements Management System (RMS) developed by the USIGS community will be one of the systems that provides tasking to CIGSS. Tasking may also be received from JCMT, ATO or ad hoc tasking from the command controlling CIGSS. Hence, collection and exploitation requirements received at the CIGSS may be in the form of RMS-formatted requests, ATOs or other format messages or database transfers.

CIGSS will integrate received requirements, prioritize them and will allocate collection requirements either to the operating airborne collection sensors, or request images from national sensors through DDS DE. Some of the requirements may be allocated to another CIGSS that controls specific airborne sensors. Routine tasking from RMS will flow via an up-echelon collection management authority, while ad hoc tasking can be received directly from a supported task force or task force component. Depending upon the employment concept, tasking authority may be delegated to any level of echelon, to include retasking of CIGSS-controlled resources that is generated internally by CIGSS exploitation elements. The priorities in tasking a CIGSS will be set by the commander to whom the CIGSS has been assigned.

The collection management function is normally external to CIGSS. However, the supported command may choose to attach this function to CIGSS and introduce tasking (in addition to tasking through RMS, etc.) in terms of Essential Elements of Information (EEI). In this case the added collection management function must convert the EEIs into imagery collection requests, similar to those received from RMS.

2.1.2 Mission Planning

To satisfy multiple imagery collection requirements, mission planning involves the aggregation of collection requirements by target location, timeliness (when needed), and sensor and assigns them to specific collection platforms and sensors.

The CIGSS employs computerized mission planning tools to prioritize and plan the execution of incoming collection requirements by airborne collectors and CIGSS resources. Mission planning also keeps track of the execution status of outstanding requirements until completed. Computerized mission planning systems perform three essential functions:

a. Plot the flights of aircraft platforms (ground tracks versus time), for ingress and egress to collection area, and the loops or orbits over the collection area.

b. Planning of sensor collection operations, to accomplish the collection of the required images of targets, or other sensor data such as phase history data, complex imagery, or Moving Target Indicator (MTI) data. This planning function takes into account environmental factors, such as weather, and the platform's operational characteristics that affect sensor operation.

c. Planning of the communications operations with the collection platform, for the imagery data reception at CIGSS, as well as the reception of non-IMINT data and the accomplishment of a variety of other functions (sensor control, threat warning, aircraft mission control, etc.). The air-to-ground links selected (line-of-sight, with aircraft relay, with satellite relay) must be available at the precise times needed and suitable for the mission.

2.1.3 Mission Control

While an airborne collection mission is ongoing, the platform operating element monitors its progress and controls in real time the operations of the platform, the sensor(s), and the communications links. In such a case, CIGSS would interface to the platform operating elements of an airborne reconnaissance platform and exchange mission planning data and receive sensor data. However, it may be advantageous to integrate some or all of mission control functions into a CIGSS, which would then be capable of performing these functions. When a Service or Agency elects to have mission control functions integrated in a CIGSS, coordination with the respective platform operating U&S commands or commands controlling the necessary data links will assure a proper operational interface.

In either case, CIGSS would have the capability to retask the platform, the sensors, and the communications systems employed while the mission is ongoing and in response to cueing information received from SIGINT sources or other nodes of USIGS. The capability for dynamic retasking is critical for responding effectively to rapid developments in a conflict or war and is essential for the rapid targeting of precision weapons. Adequate geolocational accuracy is another necessary condition.

2.1.4 Reception of Sensor Data

CIGSS will have the capability to receive, process, and store image data from a variety of sensors, national airborne and commercial. This is a significant departure from the migration GSS which were designed to accept image data from a small set of sensors. This will provide flexibility to Theater or JTF commands, which in the past needed a separate GSS for national imagery and specialized GSS for each of the various platforms/sensors.

To accomplish this function, CIGSS would be equipped with receivers for data communications links that supply national or airborne sensor data. According to DoD policy, image data received directly from an airborne sensor would be transmitted through a Common Data Link (CDL) system, which is a CIGSS core component. The reception of image data from airborne and commercial systems that use communication links other than CDL provides more choices for the reception of airborne sensor data. For example airborne sensor data can be received from a Ku band satellite link through MCE, and MOBSTR or DIOP. UAV sensor data can be received either directly from the UAV with a CDL link or as already processed images from the UAV Mission Control Element (MCE).

National images will be ordered and received through the DDS DE which is a CIGSS core component, but they may also be received through the IPL.

Proliferation of input sources provides flexibility for CIGSS deployment and operations, but will require specialized receivers, thus increasing the quantity and variety of receiver equipment that must be inventoried and possibly deployed with CIGSS. A key interoperability objective would be to migrate all special communications systems to the CDL standard. The reception of sensor data may include error correction for transmission errors and decryption.

Primary and secondary images as well as exploitation products could be received from another CIGSS or a national exploitation site through the USIGS or a GBS receiver.

2.1.5 Processing of Sensor Data

Sensor data received at a CIGSS may require a very large number of processing operations to assemble the raw data into images or other exploitable formats like video, MTI, complex images or maps. The processing operations tend to be specialized to the sensors and in the past were the driving force for the development of stovepipe GSS. CIGSS will utilize the Common Image Processor (CIP) core component which can be configured by software to perform a variety of data processing operations and hence will be able to process data (that meet certain standards) from a variety of sensors. Decompression, extraction of exploitation support data, and recompression are expected to be some of the common processing operations that will be performed for all sensor data.

Processing operations may result in digital images for softcopy exploitation or hardcopy images to be viewed in light tables, or other products. Softcopy images offer advantages for image archiving, handling, and dissemination and represent the future of CIGSS. Hardcopy images could still be in use for a variety of reasons, and CIGSS may be required to produce and exploit such images.

2.1.6 Imagery Exploitation

This function of CIGSS extracts information from the primary imagery produced by data processing or delivered to CIGSS from other sources. Imagery Analysts (IAs) perform the exploitation function using computer-based imagery workstations for softcopy images or light tables for hardcopy images. Imagery exploitation is a complex function requiring:

a. Instructions to the IAs defining the information to be extracted from each image and the user intelligence needs.

b. Collateral databases supplying the already known information about enemy units, targets, the terrain, and weather.

c. Automated management of exploitation tasks, to assure that the exploitation effort is correctly prioritized and supports effectively the warfighter needs for information in a timely manner.

CIGSS will have a common component, the Imagery Exploitation Support System (IESS) to manage and support the exploitation effort.

CIGSS may be tasked to carry out a variety of exploitation tasks. The tasks described below are some of baseline tasks.

Image Inspection. Inspection of the imagery after processing may be conducted to determine cloud cover, image quality, target coverage, etc. It is essentially a quality control task to evaluate the imagery with respect to collection requirements and its suitability for imagery exploitation. If the imagery produced does not meet the user needs, a decision may be made to retask the collection of certain targets.

Image Screening. Rapid exploitation of real-time imagery is a necessity for a variety of sensors (e.g. ATARS, ASARS-2, SYERS). It supports the JORD emphasis on real-time IMINT delivery to the warfighter. Screening also addresses the demanding requirements of wide-area search for mobile targets. This capability is receiving increasing emphasis as tactical UAVs come into wider use. Image screening can be thought as a rapid exploitation product and supports the increasingly important area of Real-Time Information to the Cockpit (RTIC).

Secondary Image Preparation. Another exploitation task is preparation of imagery for Secondary Image Dissemination (SID). A secondary image is a portion of a primary image containing only the target of interest to a user and is usually annotated. Secondary imagery allows smaller tactical units to photointerpret images of their targets of interest, without being burdened by the data storage and transmission requirements of the primary images. Secondary images may be exploitation products of primary image interpretation, or they could be produced with minimal interpretation by extracting only the image portions containing the desired targets. This function also includes the appropriate downgrading of security classification for the secondary images.

Geographic Data Extraction. A variety of geographic information about enemy territory and targets correlated with IMINT information is needed by the warfighter. CIGSS is required to provide this capability. Instead of the past practice of using separate systems for geographic data extraction, the CIGSS exploitation subsystem will include geographic data extraction applications.

Mensuration Capability. CIGSS will provide to the IAs the capability to make measurements on images and translate these to target dimensions through the use of sensor geometric models. The RULER application provides this capability.

2.1.7 Image Storage

Primary images, secondary images, and exploitation reports need to be stored in CIGSS and made available to all potential users, local and remote through networks. Since imagery and IMINT products are perishable with time during a conflict, the storage period may be limited and determined by operational needs and/or available storage capacity. CIGSS will have the Image Product Library (IPL), which is a CIGSS core component and interoperable with other IPLs in the USIGS architecture.

The IPL at CIGSS is expected to be partitioned between a public library and a private library. The private library will be reserved for the CIGSS internal users and is expected to provide storage space for primary images, work in process and output products reserved for internal users. The private library would be dedicated to supporting the CIGSS operations with no interference by external users. The public library is expected to contain secondary imagery and exploitation products available to external users.

2.1.8 External Communications

A key characteristic of CIGSS, which is a significant departure from the legacy GSS, is an enhanced need for operational interaction and communications with tasking sources, remote users, other CIGSS, and other nodes of USIGS. IMINT problems will be solved in a distributed and collaborative manner to achieve an effective use of the aggregate processing and exploitation resources, and there will be extensive sharing of resources, imagery, and exploitation products. NIMA's USIGS Objective Architecture requires the imagery exploitation in support of an MRC to be carried by exploitation sites distributed worldwide, wherever Imagery Analyst cadres are available. This concept requires extensive human and computer-originated message traffic in and out of CIGSS.

2.1.9 Imagery and Products Dissemination

CIGSS will be required to disseminate some primary imagery, secondary imagery, and certain exploitation products to other CIGSS and to users through the Global Broadcasting System (GBS), the USIGS architecture, and tactical nets. The users obtain imagery and IMINT products by two methods:

a. A "Pull" method by remotely accessing the CIGSS IPL on their own through USIGS and retrieving imagery and/or products that meet their needs.

b. A "Push" method by which certain imagery and products are selected at the CIGSS and are transmitted to one or more users. The selection will be based on dissemination requirements established by the users and prioritized by the command in charge of the CIGSS. The available bandwidth and timelines for this type of traffic is expected to be limited, so the prioritization scheme will tend to favor secondary imagery and exploitation products. Time-critical IMINT products of interest to many users will likely be broadcast through GBS. During an MRC a large volume of airborne sensor primary imagery may be processed at a CIGSS, which may not be exploitable expeditiously at the same CIGSS. A large portion of this primary imagery may have to be sent to distant exploitation centers by satellite or fiberoptic relay communication systems.

The term "dissemination" employed in this section is the one defined by the USIGS architecture, such that it means dissemination of images and imagery products from a CIGSS to users. It should not be confused with the "dissemination" terminology employed in IESS documents, which really means the selection of national images to be disseminated by DDS DE to the CIGSS. The true definition of this activity should be "Selection of national images to be received from DDS."

The dissemination function at CIGSS controls the selection and transmission scheduling of the imagery and products to be disseminated. It also controls the dissemination operations.

2.2 DoD C4I Interoperability Objectives

The evolution of national military strategy in the post cold war era and the lessons learned from the Desert Shield/Desert Storm conflict have resulted in a new vision for the DoD known as C4I For The Warrior. Its principal objective is to make information available to the warrior at any time and from any place in order to maximize the effectiveness of forces and provide a decisive edge in combat. Recognizing the need for jointness in combat and the reality of a shrinking budget, the Assistant Secretary of Defense (ASD) for C3I issued a memorandum on 14 November 1995 to Service and Agency principals, tasking them to "reach a consensus of a working set of standards" and "establish a single, unifying DoD technical architecture that will become binding on all future DoD C4I acquisitions," so that "new systems can be born joint and interoperable and existing systems will have a baseline to move towards to ensure interoperability."

The results of this direction from the ASD/C3I were the Joint Technical Architecture (JTA) and the Defense Information Infrastructure (DII) Common Operating Environment (COE). For example, the purpose of JTA is:

a. To provide the foundation for a seamless flow of information and interoperability among all tactical, strategic, and sustaining base systems that produce, use, or exchange information electronically.

b. To mandate standards and guidelines for system development and acquisition that will significantly reduce cost, development time, and fielding time for improved systems, while minimizing the impact on program performance wherever possible.

c. To influence the direction of the information industry's standards-based product development by stating the DoD's direction and investment so that information industry's development can be more readily leveraged in systems within DoD.

d. To communicate DoD's intent to use open systems products and implementations to industry. DoD will buy commercial products and systems, which use open standards, to obtain the most value for limited procurement dollars.

Joint Working Groups were established to define JTA and DII COE. DISA was assigned by the ASD/C3I the task of coordinating the selection of interoperability standards and documenting and maintaining the JTA and the DII COE. In that role DISA has a mission to be the keeper of standards for joint interoperability of DoD information systems. Similarly, NIMA has a mission to be the developer of joint imagery and imagery product architectures and the keeper of standards on all aspects of imagery support to the warrior.

2.2.1 Joint Technical Architecture

The JTA is a document that identifies a common set of mandatory information technology standards and guidelines to be used in all Command, Control, Communications, Computers, and Intelligence (C4I) systems and the interfaces of C4I systems with weapon systems, sensors, models, and simulations. JTA as a technical architecture defines a set of rules, or "building codes" to achieve interoperability, that are applied when a system is being developed or upgraded. The JTA standards are to be used for sending and receiving information (information transfer standards such as Internet Protocol suite), for understanding the information content (format standards or image interpretation standards), and for processing that information. The JTA also includes a common human-computer interface and "rules" for protecting the information, such as information security standards.

The JTA Version 1.0 has been signed by the ASD (C3I), the Under Secretary of Defense (USD) Acquisition and Technology (A&T), and the Service Acquisition Executives and is official as of 22 August 1996. JTA Version 1.0 applies only to C4I systems. Hence, it applies to CIGSS and all existing GSS as they migrate towards CIGSS. It applies to all modifications/upgrades of existing GSS, which are to migrate to the applicable JTA standards, taking into consideration cost, schedule, and performance impacts. The Services, Agencies, and other components are responsible for the implementation of the JTA (including enforcement, budgeting, and determining the pace of standards compliance). Hence, it is the responsibility of the GSS PMOs to budget, plan, and implement for the compliance of their systems to JTA standards. When cost, schedule, or performance factors limit full compliance of a GSS for a period of time, the respective PMO will be responsible for securing the necessary waivers. Since, the JTA standards apply to CIGSS, they will be addressed in this CIGSS Handbook. Specific standards in the JTA will be applied to parts of the CIGSS Reference Model, so that CIGSS will be compliant with JTA.

The JTA draws on the Technical Architecture Framework for Information Management (TAFIM). However, the JTA supersedes the TAFIM for C4I systems, while TAFIM's Volume 7 is still in force for other domains (non-C4I).

2.2.2 DII COE

The DII COE is a specific implementation of JTA. DII COE is the foundation of the Global Command and Control System (GCCS) and the Global Combat Support Systems. GCCS will be used to connect CIGSS to its users. Much of the information message traffic and the dissemination of CIGSS secondary imagery and other products will be carried by GCCS. CIGSS compatibility with DII COE is necessary for the CIGSS message traffic and products to reach and be seamlessly employed by the CIGSS users.

The DII COE is more than an architecture and a collection of standards and guidelines. In addition, it is:

a. An approach for designing information systems.
b. A collection of reusable software.
c. A software infrastructure.

When a system is being designed on the basis of DII COE, all mission-specific functions data and terminology are carefully segregated in the mission application software, while the three layers of the COE (the Kernel, Infrastructure Services, and Common Support Applications) are free from mission-specific data or terminology. This design permits:

a. The COE to be reusable and transportable from one system to another system.
b. The COE to be upgraded without affecting the mission application.
c. The mission application to be modified without affecting the COE.

Because the COE embodies a specific design methodology, it is best suited for the design of new systems. For a legacy GSS, it will likely not be cost effective to migrate to the COE as a modification, because mission application specific functions and terminology tend to be embedded into its software infrastructure. However, a legacy GSS could be modified to integrate COE components and comply with COE standards.

Version 3.0 of COE was released by DISA on 31 October 1996, while Version 4.0 is planned for the first quarter of 1998. DISA is currently making the Version 3.0 software and application software development tools available to DoD developers. These should reduce the costs of adopting COE. The timetable for the COE integration into the GSS depends on when the COE Versions become defined and available, as well as the timetables of integration of the COE by the GSS users. Since, the COE will be implemented by the DoD users of GSS products, it is essential for the GSS to be ready to supply products and services to their users at the time the majority of users have implemented the COE and are expecting the additional services that are possible by adoption of the COE.

2.3 USIGS Architecture

The USIGS architecture has been defined to solve interoperability and service to users problems for the functions of imagery exploitation and information dissemination. This architecture is based on electronic data connectivity and advanced information systems technology. USIGS coincides with the transition of imaging technology from analog images (on photographic film) to digital images stored and handled by computer systems. The benefits of USIGS apply primarily to the storage, exploitation, and dissemination of digital images.

The objective of USIGS is to enable:

a. The sharing of data (imagery and products) among exploitation sites and users.

b. The sharing of services so that exploitation or dissemination tasks can be assigned dynamically to take advantage of the global availability of imagery analysis and communications resources and to expeditiously satisfy user needs.

c. The sharing of resources, so that an exploitation site can arrange to use remotely the hardware and software resources of other sites in order to expedite the completion of its work.

The USIGS includes all parts of the intelligence cycle: collection management, collection, processing, exploitation, and dissemination. Collection and processing require specialized hardware systems. Hence, recent efforts to define standards and interfaces for the USIGS architecture are focusing on exploitation, dissemination, and collection management. The USIGS Technical Architecture is defined in terms of a group of "elements," each of which consists of a number of distinct services.

2.3.1 Accelerated Architecture Acquisition Initiative (A3I)

The Accelerated Architecture Acquisition Initiative (A3I) was started in 1995 to establish a fundamental baseline for the objective Imagery Information Service, which is part of USIGS. A3I will deliver real-time imagery and imagery products to users. The goal of A3I is to connect exploitation centers with each other and with user organizations, using high-speed, wide-area networks. A3I also has focused on developing the softcopy infrastructure at each site, consisting of a high-speed local area network (LAN), softcopy workstations, and a digital Image Product Archive. IPAs are currently being converted to Image Product Libraries.

2.3.2 USIGS Documents

Central Imagery Office (CIO) has published several documents for the definition of the USIS architecture on the USIS objective architecture, its concept of operations, its technical architecture requirements, and its standards and guidelines. Of these, the *USIS Standards and Guidelines* (13 October 1995) contains imagery data interchange services standards and graphics services standards. It also contains a large number of proposed standards to be acted upon. Since the CIO was merged into NIMA, the new versions of these documents will be NIMA documents.

2.3.2.1 Imagery Archive Standards

CIO has published several standards documents for imagery access from an archive and for storage of images. Examples are:

a. *Image Access Services Specification.*
b. *Common Imagery Interoperability Profile for Image Access.*
c. *Standards Profile for Imagery Access.*

2.3.2.2 Imagery Dissemination Standards

CIO has also published the *USIS Standards Profile for Imagery Distribution*.

2.3.2.3 Common Imagery Interoperability Facilities (CIIF) Reference Model

NIMA has recently approved also the *Geospatial and Imagery Interoperability Facilities Reference Model*, which is the new version of CIO's *Common Imagery Interoperability Facilities Reference Model* The GIIF Reference Model specifies a framework for developing open and standardized Application Program Interfaces (APIs) between architectural elements of the USIGS. This Reference Model constrains the architecture, the services provided, and the interfaces (internal and external) of a USIGS-compliant site. The GIIF Reference Model is comprised of four architectural components:

a. Distributed Computing Infrastructure
b. Common Services Architecture
c. Common Facilities Architecture
d. Imagery Interfaces

The GIIF Reference Model is very similar to DII COE and serves similar purposes.

2.4 CIGSS JORD

The CIGSS Joint Operational Requirements Document (JORD) defines the Joint Operational Requirements for CIGSS and the GSS as they migrate towards the CIGSS Reference Model. The JORD emphasizes interoperability and near-real-time IMINT delivery to the warfighter to support precision weapons employment and the decision-making and force-execution process in a dynamic battlefield.

The JORD requires that CIGSS be the model for a family of deployable, standards-compliant, modular, and interoperable processing and exploitation systems that are capable of supporting any JTF and/or Unified Command requirements. Each system should be capable of processing image data from any sensor, national or airborne. A CIGSS-compliant system should be modular to allow a JTF to scale and configure it so that it best satisfies the needs of the JTF or the parent Service, without necessitating the deployment of excess equipment. It should also allow the parent Service to add Service-unique functions.

The JORD also includes a set of required performance parameters, "core" components, interfaces to other systems, data formats, and standards. Adherence to GCCS standards is specifically mentioned. The JORD does not provide a detailed description of "interoperability" but points to other DoD efforts to achieve interoperability, such as DISA's JTA and DII COE or NIMA's USIGS architecture.

2.5 CIGSS Interoperability Objectives

The interoperability objectives for Version 1.0 of the Handbook were focused on the ability of various GSS to transmit and exploit each other's image data. The interoperability objectives for Version 2.0 define the capabilities and/or functionality needed to meet the interoperability requirements of the JORD, the USIGS and the JTA. The interoperability objectives for the CIGSS Operational Architecture are described below:

No. 1. <u>Capability to receive and process image data from any sensor.</u>

<u>This objective is in the JORD (par 3.3, 4.1.2.1, 4.1.2.3, 4.1.2.4)</u>. Any sensor basically means any existing sensor that provides image data as well as SDE data. Some sensors provide unprocessed data while other sensors deliver processed image

data. Unprocessed data will be processed by the CIP which is a mandated core component. Therefore, the group of sensors whose data require processing is defined by the CIP. The remaining sensors (delivering processed images and SDE) are defined by the capabilities of DDS DE and the IPL. Such sensors must deliver data in specific formats (NITF 2.0 with SDE extensions and TFRD). As time progresses, it may become desirable for CIGSS to receive data from additional sensors which at that time might be incompatible with the CIP, CIGSS LAN, or IPL. Decisions could then be made to modify the CIP, or the CIGSS LAN, or the IPL to accommodate the new sensor data.

No. 2. Capability to receive and operationally respond to cues from other sources.

This objective is derived from the JORD (par 4.1.2.16, 4.1.2.18, 4.1.4.2.2). Cues may arrive in various forms: telephone calls, text reports or electronic messages. Existing GSS have the capability to respond to telephone call and text cues, because they involve ad hoc processing by GSS staff personnel. This approach works well for occasional cues coming from various sources. However, responding to many cues that are time critical requires reduction of the labor intensive aspects of processing cues. Hence, the intent of the above objective is to receive the cues electronically and to have the CIGSS software prioritize the response to each cue and to adjust the mission planning of the collectors automatically with some level of human supervision to insure that the automatic process does not get out of control.

For the automatic process to work, a cue source would send messages in standard formats, and the content of the messages must contain a minimum amount of information for CIGSS to be able to identify the target(s), understand what information is needed in order to select the appropriate collection sensor(s), evaluate its priority among other collection requirements, and readjust the mission plans. To automate the cue response both the format of the cue messages and their contents need to be standardized.

No. 3. Capability to receive and exploit primary images from other CIGSS or other image sources.

This objective is derived from the JORD (par 4.1.2.22, 6.3.1, 6.4) and the USIS Objective Architecture (par 5.3.1).

This objective is required to be satisfied only if the primary imagery is delivered in the specified formats (NITF 2.0 and TFRD) with the required SDE. Delivery of the imagery must occur through the channels defined in this Handbook (CDL, DDS DE, GCCS, GBS) and coordinated with the receiving CIGSS. The JORD requires reception of image data from sensors operated by allies and DoD sensors not in the DARP (par 6.3.1). This will be possible after NATO imagery format standards have been mutually agreed upon

No. 4. CIGSS to support the distributed exploitation concept which is the capability to schedule and allocate primary imagery and exploitation tasks among CIGSS and/or exploitation centers distributed worldwide.

This objective is derived from the JORD (par 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.2.11, 4.1.2.15, 4.1.2.16, 4.1.2.18, 4.1.2.19, 4.1.2.21, 4.1.2.22) and the USIS Objective Architecture (par 5.3.2).

This objective can be satisfied if the various CIGSS and exploitation centers supporting military operations are able to communicate with each other and coordinate their exploitation tasks. During a conflict, a number of exploitation units (CIGSS, JICs and other distributed exploitation centers) may be assigned to support military operations of a JTF command with timely exploitation of imagery. Exploitation tasking for the exploitation units assigned to support the JTF will come from an exploitation coordinator designated by the JTF J-2, probably the J-2's Collection Manager. The exploitation units will coordinate between each other for the transfer of imagery to accomplish the exploitation tasks assigned to them. The exploitation tasking and coordination between exploitation units is accomplished today using the telephone. A more efficient method would employ the transmission of standardized computer messages or exploitation schedules. There has also been some discussion about a USIGS Integrated Management Initiative, that may formalize the distributed exploitation process.

This objective assumes that communication channels of adequate bandwidth connect the exploitation units participating in a distributed exploitation network, and that interoperability objective No. 3 above is satisfied.

No. 5. CIGSS-produced secondary imagery and exploitation products to be directly useable by other CIGSS and the joint warfighter in general.

This objective is derived from the JORD (par 1.2, 1.3, 3.3, 4.1.2.2, 4.1.2.3, 4.1.2.5, 4.1.2.7, 4.1.2.9, 4.1.2.11, 4.1.2.12, 4.1.2.14, 4.1.2.15, 4.1.2.16, 4.1.2.18, 4.1.2.21, 4.1.2.22, the USIS Objective Architecture (par 5.3.1), and the JTA (par 1.1.4, 1.1.5).

This objective implies that secondary imagery and exploitation products comply with specific standards, so that they can be exploited by other CIGSS and any user whose workstations are compliant with the same standards. This objective is central to NIMA's standardization efforts (IPL, IASS, etc.) and the requirement for DII COE compliance to Level 5.0.

No. 6. The CIGSS to be based on commercial open systems standards.

This objective is derived from the JORD (par 1.2, 3.3, 4.1.2.4.7, 4.1.2.7.3, 4.1.2.16, 4.1.3, 4.1.4, 4.3.2, 4.3.6, 4.3.7, and JTA (par 1.1.8).

Selection of commercial open systems standards has been the guiding principle for the definition of JTA, DII COE, and the USIGS documents. Since the CIGSS standards are derived from those documents, this objective is satisfied.

No. 7 <u>CIGSS Connectivity with other CIGSS and C4I Resources.</u>

<u>This objective is derived from the JORD (par 6.1, 6.1.2.3).</u> The JORD requires CIGSS compliant GSS to be connected through GCCS and other communication systems with other CIGSS compliant GSS and C4I resources for intelligence sharing and product dissemination. CIGSS must be compliant with DII COE Level 5.0.

Table 2-1 provides a traceability matrix of the interoperability objectives to the appropriate paragraphs of the foundation documents.

Table 2-1. Traceability Matrix of Interoperability Objectives

Interoperability Objective	Foundation Document Paragraphs
No. 1	JORD – 3.3, 4.1.2.1, 4.1.2.3, 4.1.2.4
No. 2	JORD – 4.1.2.16, 4.1.2.18, 4.1.4.2.2
No. 3	JORD – 4.1.2.22, 6.3.1, 6.4 USIS Obj. Arch. – 5.3.1
No. 4	JORD – 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.2.11, 4.1.2.15, 4.1.2.16, 4.1.2.19, 4.1.2.21, 4.1.2.22 USIS Obj. Arch. – 5.3.2
No. 5	JORD – 1.2, 1.3, 3.3, 4.1.2.2, 4.1.2.3, 4.1.2.5, 4.1.2.7, 4.1.2.9, 4.1.2.11, 4.1.2.12, 4.1.2.14, 4.1.2.15, 4.1.2.16, 4.1.2.18, 4.1.2.21, 4.1.2.22, USIS Obj. Arch. – 5.3.1 JTA – 1.1.4, 1.1.5
No. 6	JORD – 1.2, 3.3, 4.1.2.4.7, 4.1.2.7.3, 4.1.2.16, 4.1.3, 4.1.4, 4.3.2, 4.3.6, 4.3.7, JTA – 1.1.8
No. 7	JORD – 6.1, 6.1.2.3

2.6 Commonality, Modularity, and Scaleability Objectives

The commonality, modularity and scaleability objectives for CIGSS are based on JORD and USIGS requirements, and are described below:

No. 1 <u>CIGSS architecture to employ common, modular components.</u>

<u>This objective is derived from the JORD (par 1.2, 3.3, 4.3.2, 4.3.6)</u>. Core components in the CIGSS Reference Model provide common implementations for

similar GSS functions, so that the development of a core component usable by several different GSS is paid only once.

No. 2. CIGSS compliant GSS to be modular and scalable to meet the JORD requirements.

This objective is derived from the JORD (par 1.2, 1.3, 3.3, 4.1.3, 4.3.2, 4.3.6, 4.3.7. The JORD stipulates the CIGSS to be modular with common components to allow scaleability by adding additional components and for the purpose of increasing performance as needed by the JTF. This objective is implemented in the CIGSS Reference Model by the open systems client-server architecture and the core components. Core components are specifically mandated in the JORD. The CIGSS architecture allows the addition of multiple core components to increase the CIGSS performance.

No. 3. The CIGSS architecture to facilitate rapid modification and/or integration of GSS.

This objective is derived from the JORD (par 1.2, 3.3, 4.1.2.4.7, 4.1.2.7.3, 4.1.2.16, 4.1.3, 4.1.4, 4.3.2, 4.3.6, 4.3.7).

This objective is implemented in the CIGSS Reference Model by the open systems client-server architecture and the core components. As more core components are developed and the Reference Model interfaces are defined in more detail, the integration of GSS from Reference Model components will be simplified and accelerated.

No. 4. The CIGSS architecture to promote the migration of ground stations to DCGSS

This is a DARO objective to facilitate the integration of IMINT, SIGINT and MASINT ground processing and exploitation stations into integrated GSS. This objective is derived from ARITA and DARO policy

The CIGSS Reference Model has a similar architecture to the JASA ground station and matches the ARITA Functional Reference Model guidelines. Evolution of CIGSS to DCGSS will become possible with convergence of CIGSS and JASA standards and core components.

2.7 GSS Compliance to CIGSS

CIGSS is the architectural model of the DARO objective architecture for the future GSS, and it is defined by its Reference Model. CIGSS needs to be differentiated from the GSS, which will be real systems, but not identical with each other or the CIGSS Reference Model. The architecture allows a variety of GSS implementations, but there is only one architectural model. This definition eliminates the confusion resulting when people think that the CIGSS Reference Model represents at a higher level the detailed design of each GSS.

A GSS is defined by its system requirements that reflect the mission its primary user wants it to fulfill. Hence, a GSS will often provide special functions of interest to the primary user, that are not in the CIGSS Reference Model. However, the Reference Model will contain all functions that are common to many GSS. The purpose of the CIGSS architecture is to provide common implementations for the common functions. Standardizing the implementations of the common functions, while retaining the flexibility of adding special functions is a key feature of the CIGSS Reference Model, which implements the modularity objectives (Numbers 1 through 4) above with a specific architecture and core components. The intent is to enable GSS developers to integrate ground systems using CIGSS core components.

The interoperability standards of the CIGSS Reference Model should be viewed as “building codes” that apply to all ground based equipment or systems in the DARP.

2.7.1 CIGSS Architecture Compliance

A decision memorandum signed by the Undersecretary of Defense for Acquisition and Testing (USD (A&T)) mandates that all GSS in the DARP shall comply with the CIGSS architecture. The compliance ground rules defined below take into consideration the variability of the GSS capabilities while preserving the flexibility in scaling or modifying the GSS.

It is noted that GSS may be integrated that have some or all the functions in the CIGSS Reference Model. <u>For CIGSS compliant GSS the following ground rules apply:</u>

Ground Rule #1. Each GSS shall have the open system infrastructure supporting the attachment of functions to the LAN as defined in the CIGSS Reference Model, and comply with the CIGSS interoperability standards. The reason is that it is required to preserve the expansion potential of each GSS by future addition of CIGSS core components.

Ground Rule #2. A GSS is not required to provide all baseline CIGSS functions shown in the Reference Model. However, each GSS function that matches a CIGSS baseline function must be implemented as specified in the CIGSS Reference Model (standards and core components for that function). This reduces the variety of components performing the same function (reduced development cost), preserves the flexibility for future modification of GSS and allows the reuse of components.

Ground Rule #3. Each GSS special function (does not match any CIGSS baseline function) must comply with the CIGSS standards for connection to the GSS infrastructure. This eliminates the possibility of special functions conflicting with CIGSS core components and preventing their future integration into the GSS.

GSS that satisfy all three of the above ground rules will be viewed as CIGSS architecture compliant. Verification of such compliance will follow a process summarized in section 4. of this Handbook and defined in a separate document titled the CIGSS Overarching Test & Evaluation Plan.

2.7.2 CIGSS JORD Compliance

Specific GSS are required to satisfy the CIGSS mission and meet the JORD requirements. Other GSS (TCS, MCE, etc.) are not intended to satisfy the CIGSS mission. The JORD stipulates both functionality and performance. JORD compliance has a special meaning. It means a GSS is a complete implementation of the CIGSS Reference Model with all the functions and core components and is capable of fully supporting a JTF during war.

GSS that meet the JORD compliance will be tested and verified by JITC as defined in the OTEP. The verification process will result in a GSS being assigned to one of three categories:

a. **Full JORD Compliance.** The GSS meets all the requirements of the Reference Model and the JORD as tested.

b. **JORD Capable.** The GSS is compliant with the CIGSS architecture but may not have all the Reference Model functions and core components. Furthermore, it does not meet all the JORD requirements. However, it is capable of reaching JORD compliance, if the capability for rapid migration to Full JORD Compliance can be demonstrated by the addition of core components. This category is important for GSS which are not JORD compliant in peacetime, but can be brought up to full compliance rapidly during a conflict by the addition of additional core components. The migration path to full compliance and the inventory of additional components needed for full compliance must be real.

c. **JORD Noncompliant.** The GSS may implement some CIGSS functions in a noncompliant way, even though it has some other functions that are CIGSS architecture compliant. The noncompliance may vary from minor to major, and can only be defined in a detailed verification report. Such GSS may nevertheless be useful in a conflict, if they can be connected with other GSS that offer complementary functions.

2.7.3 Inventory of GSS

It is worth mentioning that the situation that stresses the ability of GSS to satisfy JTF needs is a sudden break of a Major Regional Conflict (MRC). In the beginning of an MRC the available peacetime inventory of GSS and their capabilities are crucial in enabling the DoD to support adequately the JTF commander. It is a

DARO strategy to use the CIGSS architecture to preserve the flexibility of reconfiguring GSS during an MRC and to make maximum use of the inventory (hardware, software and full systems) available at the beginning of a conflict. Key parts of the strategy are the use of core components and the ability to connect together smaller systems to generate the throughput of larger systems.

3. CIGSS OPERATIONAL ARCHITECTURE

The CIGSS functional architecture provides for the functions to be connected as applications on a client-server network (Figure 3-1). The purpose is to have an open systems scaleable architecture based on standards such that capabilities or functions can be added, removed, or upgraded easily. Special mission applications can be added as application software provided with standard APIs and attached to the network. There is no longer any need to employ custom architectures in the design of a GSS in order to provide special mission applications. This architecture also provides a set of core components (CDL, DDS DE, IPL, CIP, and IESS) which can be integrated in any CIGSS compliant GSS and is fundamental for the reduction of the life-cycle costs of GSS.

The CIGSS functional architecture in Figure 3-1 shows the functions necessary to satisfy the CIGSS mission (Section 1.2), the CIGSS Concept of Operations (Section 2.1), and the JORD.

The key characteristics of the functional architecture are as follows:

a. Functions may be implemented using more than one component in a distributed fashion.

b. CIGSS has an architecture and an infrastructure that provides services to the other functions as needed. This approach eliminates the need for each function to replicate capabilities that are available as services through the CIGSS LAN. The infrastructure provides a functionality that is being described under the CIGSS Infrastructure Function (Section 3.1.8).

c. Management and control of CIGSS operations are shown as a single management function in Fig 3-1. To provide visibility to all the necessary management functions and emphasize the need for coordinating closely and integrating the operations of all functions, they have been integrated in the discussion of Section 3.1.9. This approach does not imply that the implementation of the management functions is centralized. In fact, some management functions can be allocated to the operational functions they control and then reallocated to core components. For example, the Exploitation Management function has been allocated to the Exploitation Function and then can be reallocated to IESS, if that component is implemented.

d. The functional architecture accommodates the addition of specialized functions or mission applications of interest to some users. Such specialized functions are not part of the CIGSS baseline functions and are not shown in Figure 3-1.

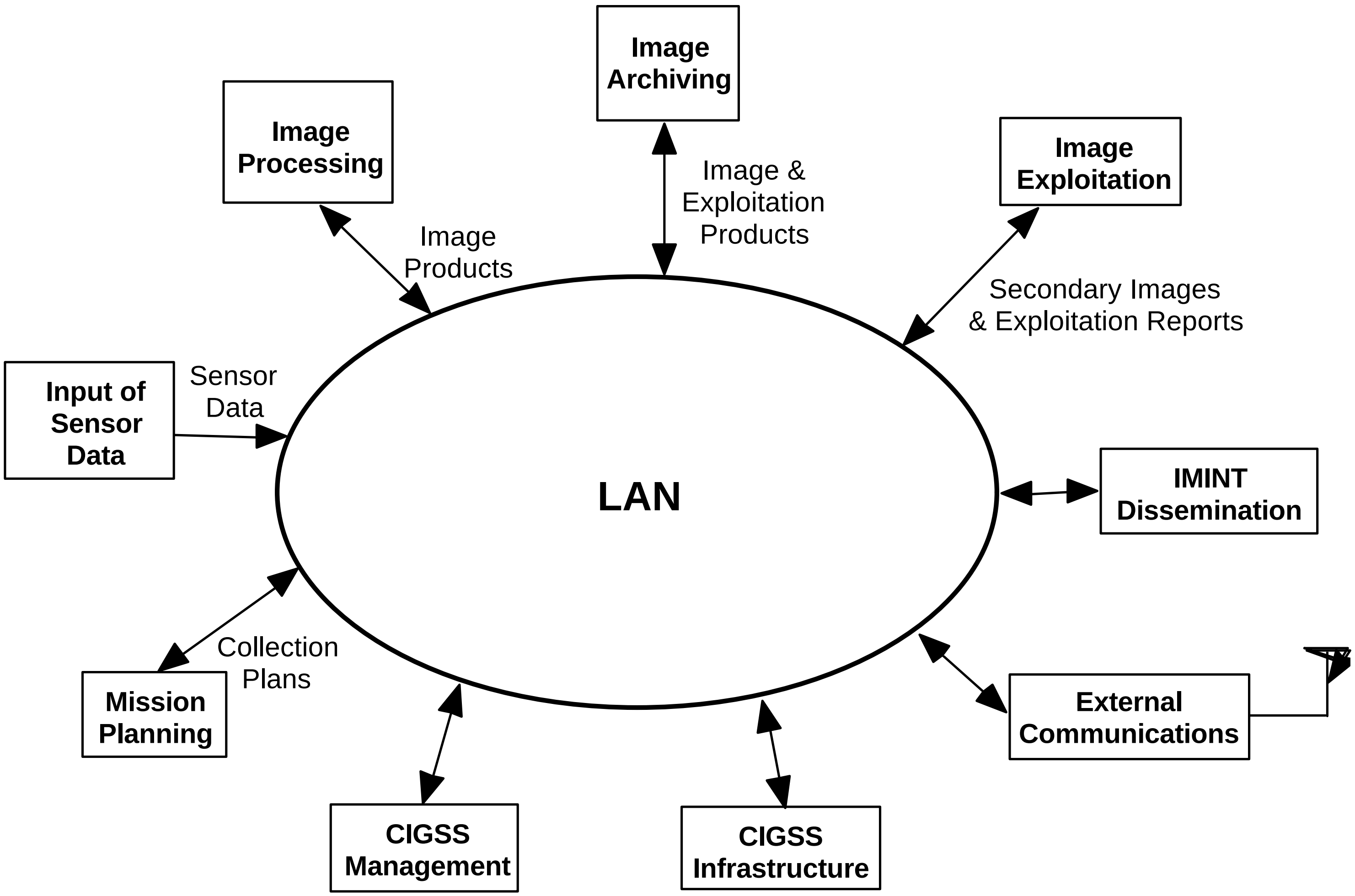

Figure 3-1. CIGSS Functional Architecture

CIGSS must provide a set of common or baseline functions. The discussion below (Sections 3.1 through 3.9) is in terms of the CIGSS baseline functions and the standards that apply to each function.

The CIGSS infrastructure provides a set of services to all other functions. Hence, the standards listed under the infrastructure function should be understood to be the common standards that apply to all functions. The standards listed for the other functions are unique to those functions.

3.1 Mission Planning

The mission planning function receives tasking from RMS as well as from any other source (JCMT or ATO, etc.) that the prime user of CIGSS may desire. The ability to receive tasking from RMS is in the CIGSS baseline and therefore mandatory. The ability to receive tasking from other sources is not excluded and can be implemented as a specialized application. The mission planning function prioritizes incoming collection requirements and develops mission plans for airborne collection systems. The planning is based on regularly updated databases of:

a. Threats (types and locations) to the airborne platforms.
b. Terrain geography.
c. Imaging targets and their locations.
d. Weather conditions versus terrain.
e. Navigational information (restricted flight zones, navigational aids, airfields.

In addition, the mission planning function employs models that describe the performance of airborne platforms and the sensors and computerized tools to assist the mission planner. The mission planning function generates three types of products:

a. A navigation plan, which is the aircraft ground track versus absolute time. It is used by the pilot or the Unmanned Aerial Vehicle (UAV) ground station to control the position and heading of the aircraft during the ingress, imaging, and egress operations.

b. An imaging collection plan, which defines the sensor's pointing and imaging operations versus time, and on-board processing plans.

c. Communications plans

Currently, the capability to do the mission planning function for a particular aircraft/sensor combination has been built into each specific GSS. The predominant mission planning systems are:

a. The Air Force Mission Management System (AFMMS)

b. The Navy Tactical Aircraft Mission Planning System (TAMPS)

Interoperability for the mission planning function requires as a minimum the definition of standard formats for exchanging mission planning data between various GSS and between the mission planning function and other functions within CIGSS. When these standard formats have been defined and approved, then individual GSS would migrate to these standard formats. The following formats have been proposed:

a. Flight or navigation plan -- RECON 2 format

b. Imaging collection plan -- a standard format to be defined as extension in Uniform Standard Message Text Format (USMTF)

c. Threat data – Air Force Mission Support System (AFMSS) OB, or the MIIDS MIDB Version 2.0

d. Restricted area data -- DMA DAFIF SUAS

e. Collection Tasking -- RMS ACRM

f. Military features data -- AFMSS Military Features

g. Aircraft position reports – U-2 Aircraft Position Message

Table 3-1 suggests standards that are needed for the mission planning function and that should be developed and approved.

Table 3-1. Interoperability Standards for Mission Planning Function Suggested but not approved

Input or Output	Standard	Availability Date
Tasking Message	RMS ACRM	TBD
Flight Plan	RECON 2 as specified in USMTF	TBD
Image Collection Plan	TBD	TBD
Threat Data	AFMSS OB	TBD
Restricted Area Data	DMA DAFIF SUAS	TBD
Military Features Data	AFMSS Military Features	TBD
Aircraft Position Reports	U-2 Aircraft Position Message	TBD

One interoperability objective requires the capability to receive and operationally respond to cues from SIGINT and other sources. This necessitates the capability to dynamically retask the collection operations during an airborne mission. The GSS that planned the mission originally can replan both the flight plan and the collection plan. However, it is desirable to have the capability to dynamically redirect the sensor collection operations from another GSS. This will be possible, if the imaging collection plan is standardized.

3.2 Input of Sensor Data

CIGSS may receive sensor data by a variety of sources. The sources could be national imaging sensors, airborne sensors, or commercial image sources. The sensor data may arrive at CIGSS through DDS DE, GCCS, airborne link (CDL), a video link, analog or digital tapes, or through a special link for commercial imagery. The sensor data may represent frame images, continuously moving (waterfall) images, video, or non-image data such as MTI, complex SAR imagery, or phase history data. The sensor data could be unprocessed sensor data requiring digital processing before it is ready for exploitation, or it may be received as processed data ready for exploitation.

For the CIGSS the baseline sensor data are national images, and airborne images and video. The DDS DE is the baseline source for national imagery. The baseline source for airborne images and video is the CDL link All other types of data and sources are not considered baseline but can be accommodated if data is received in the NITF 2.0 format.

The DDS DE is currently operational, and provides processed national imagery. In CIGSS, imagery received from the DE bypasses the CIP and may be sent to COTS exploitation workstations, to high performance IDEX workstations, to tape recorders, to the IPL, or to hard copy image recorders. National imagery delivered to the DE is compressed using the Digital Cosine Transform (DCT) and Digital Pulse Code Modulation (DPCM) algorithms as defined in the S2025P TFRD. The DE also supports the NITF 2.0 format (uncompressed) with SDE v1.1.

The airborne sensor data receiver is a Common Data Link (CDL) receiver equipment. Examples of such receivers are:

a. The Modularized Interoperable Surface Terminal (MIST).
b. The Common High Bandwidth Data Link Surface Terminal (CHBDL-ST).
c. The Tactical Interoperable Ground Data Link (TIGDL).

Airborne sensor data arriving through a CDL receiver normally requires processing and is routed to the CIP for real time processing or to tape recorders for capture and processing at a later time.

Table 3-2 summarizes the applicable standards for the Input of Sensor Data function.

Table 3-2. Interoperability Standards for Input of Sensor Data Function

Input or Output	Standard	Availability Date
DDS DE Output Images (tape or electronic input) DDS DE Output Images (LCM tape input)	NITFS 2.0 – MIL-STD-2500A (Uncompressed) TFRD - S2500P TFRD Encapsulated in NITF 2.0 - S2035 NITF 2.0 - MIL-STD-2500A (JPEG compressed)	1997 1997
DDS DE Output Image SDE	SDE Version 1.1 (TCS-037-011/95)	1997
DDS Image Request	IESS TO DDS-DE Specification D3-RSHD-8	1997
DDS DE Interface to CIGSS LAN	Imagery LAN – See Section 3.2.2.2.5 of JTA Ethernet for the Data LAN – See Section 3.2.2.2.1 of JTA	1997 1997
Airborne Sensor Data	Common Data Link – DARO CDL Segment System Specification # 7681990 - 1 May 1996	1997
Airborne Sensor SDE	Airborne SAR SDE Visible, Infrared, & MS Airborne Sensor SDE	1997

3.3 Image Processing

The Image Processing function performs digital signal processing operations on incoming sensor data and converts them to output images or primary products ready for exploitation. The baseline products of this function are images (frame and moving images). Video arrives in MPEG-2 format and does not require additional signal processing before storage at the IPL. Decompression of the video is done in real time for display in the analyst workstation.

Since the signal processor required for the Image Processing function is a high-cost development item, DARO has decided to develop a Common Imagery Processor (CIP) and to make it available for GSS integration. The CIP is a core component of CIGSS. An overview of the CIP is included in Vol. II.

Sensor data from airborne sensors are processed by the CIP and are converted to primary images (full resolution and reduced resolution image sets), or other types of output data (complex images, phase history, MTI, etc.). In Figure 3-1 the sensor data arrives either directly from the airborne sensor through a data link to the airborne sensor data receiver or by playback from the tape recorders. In either case the CIP has direct interfaces with the airborne sensor data receiver and the tape recorders that bypass the CIGSS LAN. The CIP separates the support data extension data (SDE) from the image data and forms the image data into primary images, or other output data. The primary images or output data are sent to the Exploitation Function for immediate exploitation (see Section 3.1.4) or are stored in the Image Product Library to be exploited at a later time.

The CIP interfaces with the tape recorders (ANSI ID-1 or DCRSi recorders) and the airborne sensor data receiver, which is a Common Data Link (CDL) receiver system (see Section 3.1.2). As a minimum the CIP shall be capable of receiving and processing data from all CDL channels that may be used by any of the airborne sensors. Specific interfaces of CIP to specific airborne sensor data receivers are addressed in section 3.2.1.

The CIP outputs are in NITF 2.0 File Format and ready for storage, exploitation or dissemination.

Table 3-3. Interoperability Standards for Processing Function

Input or Output	Standard	Availability Date
Sensor Data Input to CIP	CDL-derived standards S7633603 - External ICD for MIST, 16 September 1987 SPAWAR-L-8418 - CHBDL-ST System Specification, 30 June 1993 TIGDL specification ?	1997
Tape Recorder Formats	SMPTE D-1 L or D-1 M cassettes in ANSI ID-1 format ICD-F/A-18-064 - F/A-18D(RC) TAC RECCE to CIGSS ICD DCRSi Tapes 3A24591 - U-2R & ASARS-2 Airborne Radar Set (ARS) to ETRAC/MCP Interface Specification, 30 September 1994	1997
CIP Output Imagery	NITFS 2.0 MIL-STD-2500A MIL-STD-188-198A MIL-STD-188-199	1997
Data LAN	Ethernet – See Section 3.2.2.2.1 of JTA IEEE 802.3 (ISO8802/3) TCP – see Section 3.2.1.1.2.1.1 of JTA IP – see Section 3.2.1.1.2.1.3 of JTA	1997 1997
Imagery LAN	See Section 3.2.2.2.5 of JTA	1997

3.4 Image Exploitation

The Exploitation Function consists of those services required to manipulate, analyze, interpret, and extract information from imagery. It also includes report and product generation services. Further, it includes services that support the management of exploitation.

The Exploitation Function receives tasking from the Exploitation Management Function, which resides in the IESS. Imagery Analysts working from softcopy workstations retrieve primary images from the IPL or the DE and analyze these images. In addition to the SDE, which are available with the primary images from the IPL or the DE, the IAs also receive and utilize supporting data from target and other databases residing in IESS.

The IAs could be tasked to perform a variety of exploitation ta sks, one of which could be image inspection, another production of secondary imagery, another a mensuration task, and another a geospatial data extraction. Standardization of exploitation tasks and the formats of exploitation products is critical to the distributed exploitation interoperability objective. Assignment of exploitation work to remote exploitation sites will be greatly accelerated if the assignments are done in standard exploitation tasks that are known and understood by the remote IAs. Likewise, exploitation products in standard formats can be understood and digested by the users faster.

From a standards point of view, the Exploitation Function needs a variety of standards to conduct its operations:

a. Able to read the image file format and the SDE formats and definitions. As a user of IPL, it must comply with the archiving standards and utilize the Image Access services available through IPL.

b. Able to read and expand the TFRD format for national images arriving from the DDS DE.

c. Able to read the formats and definitions of the supporting data in the exploitation databases.

d. Able to perform a set of image processing and data extraction operations.

e. Able to produce a variety of exploitation products and reports in standard formats.

Table 3-4 summarizes the currently available standards applicable to the Exploitation Function. As mentioned above additional standards are needed.

Table 3-4. Interoperability Standards for Exploitation Function

Function or Interface	Standard	Availability Date
Imagery Access Services	See Section 4.1.2 *Standard Application Interfaces* of CIIP	1997
Network Access Interfaces	See Section 3.2.2.2.5 of JTA Image Transfer Element Specification – NITF 2.0 -- See Section 3.2.1.2 of SPID	1997 1997
File Format	See Section 4.1.4 of CIIP	1997
Video Standards	Video compression – MPEG-2 VWG Standards Architecture V 0.9 Core Video Metadata Profile V 1.0	1997
Workstation Performance	Image Processing – NITF 2.0 Mensuration Specification -- RULER Geospatial Data Extraction Specification -- TBD	1997
Exploitation Requirements	RMS Standard – IF2250 GB	1997
Exploitation Products	Secondary Imagery – NITF 2.0 Exploitation Reports – IIR, RECCEXREP, GRAPHREP	1997 1997
Exploitation Databases	IESS Specification	1998?

3.5 Image Archiving

The Archive Function is implemented by the Image Product Library (IPL). The IPL serves the role of storing primary images, secondary images, and exploitation products. However, the key requirement is that the IPL be a true library, allowing users to conduct remote searches for imagery and products. CIO and now NIMA have put a great emphasis on developing standards for the Imagery Access Function in general. The following standards documents pertain to this function :

a. Standards Profile for Imagery Access, CIO-2020

b. United States Imagery System Standards Profile for Imagery Archives, (SPIA), CIO ASD SIA 0594 0000

c. Geospatial and Imagery Interoperability Facilities (GIIF) Reference Model

d. Image Access Services Specification (I ASS), CIO-2068

e. Profile for Imagery Archives Extensions (PIAE)

f. Common Imagery Interoperability Profile (CIIP) for Imagery Access, CIO-2069

g. USIS Standards and Guidelines

h. Video Working Group Standards Architecture

i. Core Video Metadata Profile

j. Tape Format Requirements Document TFRD, S2500P

The Standards Profile for Imagery Access (CIO-2020) specifies the information content of the metadata for USIGS. It provides standardized terminology and definitions for the production of metadata, as well as interpreting the metadata in a USIGS archive. This standard is a subset of the Federal Geographic Data Committee's (FGDC's) *Content Standards for Digital Geospatial Metadata*, with the addition of three sections for USIGS Product Metadata, Imagery Metadata, and Computational Query Parameters.

The GIIF Reference Model specifies a framework for developing standard Application Program Interfaces (APIs).

The USIS Standards and Guidelines document focuses on imagery-specific standards applicable to the USIGS.

The IASS addresses the core <u>interoperability requirements</u> of the USIGS for access to image products. The supported operations include image product discovery, metadata attribute retrieval, whole product retrieval, and client product creation. The IASS defines the interface requirements for the following facilities included in the GIIF Reference Model:

a. Image Access Facility (IAF), for retrieval of image products

b. Catalog Access Facility (CAF), for query-based discovery of image products and retrieval of metadata attributes

c. Profile and Notification Facility (P&NF), for creation of interest profiles by clients

In the IASS the various types of interfaces are defined in the Interface Definition Language (IDL).

The CIIP defines the key interfaces and applicable specifications to the services supporting image product access operations. The fundamental principle of the CIIP is standard APIs. One can think of the CIIP as a guide to applying standards to CIIGS components. It references primarily standards contained in the IASS, SPIA, SPID, and the USIS Standards and Guidelines

The CIGSS Handbook and CIIP are complementary, with CIIP being the higher tier, architectural, and general guide to imagery standards, while the CIGSS Handbook is the lower tier extension of the CIIP, specifically for CIGSS and reflecting more detailed implementation standards. In fact, the guidelines provided by the CIIP have greatly facilitated the application of imagery standards to the CIGSS components.

Table 3-5 summarizes the standards applicable to the IPL.

Table 3-5. Interoperability Standards for Archive Function

Function or Interface	Standard	Availability Date
Imagery Access Services	See Section 4.1.2 *Standard Application Interfaces* of CIIP	1997
Network Access Interfaces	See Section 3.2.2.2.5 of JTA Image Transfer Element Specification – NITF 2.0 -- See Section 3.2.1.2 of SPID	1997 1997
File Format	See Section 4.1.4 of CIIP	1997
Video Standards	Video compression – MPEG-2 Metadata & other standards in development	1997?

3.6 IMINT Dissemination

This function receives dissemination instructions and plans/schedules from the dissemination management function and executes them. It interfaces with GBS, GCCS, and other dissemination systems externally and with the IPL and the CIGSS management function internally to synchronize the transfer of imagery and exploitation products to the dissemination systems.

Prior to dissemination, the imagery and the exploitation products reside in IPL. The management function can minimize other traffic on the CIGSS LAN to facilitate the dissemination operation. The Dissemination Function must provide a data buffering function to isolate the external dissemination links from possible time delays due to the IPL and/or LAN operation.

The imagery and exploitation products in the IPL can be in either NITF 2.0 or TFRD formats. However, some preparation of the data for dissemination will be necessary. For example, data to be sent to specific users must be addressed. Furthermore, the Dissemination Function performs a final quality check by examining the formats, headers, and SDE of imagery and exploitation products for proper format and error detection prior to dissemination.

In summary, this function accomplishes the following:

a. Executes the data dissemination schedules
b. Interacts with GBS and GCCS for the timing of image transfers
c. Provides data buffering to ensure efficient image transfers
d. Provides addresses for the data to be transferred
e. Does a final quality check on data formats, headers, etc.
f. Prepares dissemination tapes for delivery by transportable media

The Dissemination function may be assigned or distributed among IPL, IESS, or the CIGGS System Manager.

Complete and detailed standards are needed to control the formats and data contents of the imagery and exploitation products that are disseminated and ensure that users complying with the same standards can utilize these products without the need for additional data conversions. Standards governing formats and data content of imagery and exploitation products have been applied to the archive and exploitation functions (see Sections 3..4 and 3..5). Nevertheless, NIMA has an approved Standards Profile for Imagery Distribution (SPID).

The *USIS Standards Profile for Imagery Distribution (CIO-2019)* has standards for the Network Access Interface and for Media Access Interface (magnetic media). For the Network Access Interface, it has:

a. Network standards (TCP/IP, Fiber-Distributed Data Interface (FDDI), Simple Network Management Protocol (SNMP), etc.) that are overtaken by the JTA standards, which we have listed under the External Communications Function (see Section 3.1.7 and Table 3-7).

b. Image transfer standards (File Transfer Protocol (FTP), NITF 2.0). It is significant that the NITF 2.0 should be implemented using Appendix A and Tables A-I, A-II, and A-III in SPID.

For the Dissemination Function to perform addressing and quality control of disseminated products, it must comply at least with Internet Protocol, NITF 2.0, and TACO-2.

For the Media Access Interface, the SPID specifies magnetic media, either 8 mm and/or Super-VHS tape cartridges, and defines the tape directory format. Some Dissemination Functions may be allocated to the IPL. This will depend on the capabilities to be available in the IPL.

Table 3-6 defines the standards for the Dissemination Function.

Table 3-6. Interoperability Standards for Dissemination Function

Service	Standard	Availability Date
Quality Control	NITF 2.0 and Tables A-I, A-II, and A-III in SPID	1997
Addressing of Products	Internet Protocol (IP) – See Section 3.2.1.1.2.1.3 of JTA TACO-2, MIL-STD-2045-44500	1997 1997
Transportable Media	See -- Table 3.2.2-1 in SPID ATARS Tapes? DDS Tapes – RCM TFRD	1997 1997 1997

3.7 External Communications

The External Communications Function receives data to be transmitted from the other CIGSS functions and prepares it for transmission by formatting it and attaching header, error correction, and other auxiliary data. It also receives formatted data from external sources and reformats these data by stripping the auxiliary data necessary for transmission and identifying the recipient function within CIGSS. Essentially, the External Communications Function performs the two-way data transformations necessary for converting data from the CIGSS Data LAN format to the transmission formats of communications systems external to CIGSS. This function and the associated standards pertain only to data transmission. Communication with the outside world requires compliance with additional information standards, which are implemented by other functions of CIGSS but primarily the CIGSS Infrastructure Function (Section 3.1.8).

3.7.1 Communication with a Mission Ground Station of Airborne Platform

One can assume that CIGSS communicates with the mission ground stations regularly by a normal information network, either GCCS or a tactical net. The Mission Planning function of CIGSS receives information on the availability of airborne platforms, for mission planning purposes, and transmits to the ground station flight plans, imagery collection plans, and sensor data reception plans. This information allows the ground station to allocate platforms, sensors, and sensor data links and to fine tune the absolute times for the collection and reception of sensor data. The ground station then informs CIGSS of the progress of the mission and updates the flight track and imagery collection with events as they are about to occur or actually occurred.

The CIGSS baseline includes connections to GCCS and GBS for delivery of imagery, imagery products, intelligence reports as well as message traffic.

3.7.2 Transmission Standards

A GSS exchanges messages and data (as distinguished from imagery) with other GSS, USIGS sites, and its users. This information exchange must utilize standard transmission formats, network protocols, etc. The source of these standards is the JTA. Table 3-7 lists the applicable standards.

Table 3-7. Interoperability Standards for Data Transmission Function

Service	Standard	Availability Date
Transport Services	TCP/UDP over IP and OSI IIP See Section 3.2.1.1.2 of JTA TACO-2, MIL-STD-2045-44500	1997 1997
Video Teleconferencing	See Section 3.2.1.2 of JTA High Speed Teleconferencing - VTC001, Revision 1, April 25, 1995 Low Speed Teleconferencing - ITU-T H.324, March 19, 1996	1997
Facsimile	See Section 3.2.1.3 of JTA	1997
Network Services		
-- Routers	Internet Protocol is main protocol See Section 3.2.2.1 of JTA	1997
-- Point to Point Service	See Section 3.2.2.2.2 of JTA	1997
-- Combat Net Radio	See Section 3.2.2.2.3 of JTA	1997
-- ISDN	See Section 3.2.2.2.4 of JTA	1997
-- ATM -- TACO-2	See Section 3.2.2.2.5 of JTA MIL-STD- 2045-44500	1997 1997
MILSATCOM	See Section 3.2.3.1 of JTA	1997
Radio Communications	See Section 3.2.3.2 of JTA	1997
SONET	See Section 3.2.3.3 of JTA	1997

3.8 CIGSS Infrastructure

The CIGSS Infrastructure Function consists of all hardware and software components that comprise the CIGSS infrastructure and define CIGSS as an information system. The infrastructure components provide connections between all other functions and support their operation. A key CIGSS infrastructure component is the LAN shown in Figure 3-1.

There are additional requirements imposed on CIGSS from JTA, DII COE, and the GIIF that mandate an open systems architecture constrained by information systems reference models and standards. These requirements apply to the whole CIGSS and are not specific to any of the other functions. These will be discussed in this section.

Other infrastructure components are:

a. Physical shelter for the CIGSS components.
b. Heating and air conditioning equipment.
c. Electrical power.
d. Telephone and fax equipment.

Standards for these components will not be addressed in the Handbook.

Standards for the CIGSS infrastructure are based on the JTA Version 1.0 and are listed in Table 3-8. The DII COE is an implementation of JTA. "…The JTA mandates that all Command, Control, Communications, Computers, and Intelligence (C4I) systems shall use the DII COE. All applications of a system which must be integrated into the DII shall be at least DII COE I&RTS level 5 compliant…." This mandate applies to the CIGSS infrastructure function. Certain CIGSS components (CIP, tape recorders, CDL, DDS DE) are excluded from the DII COE mandate.

Table 3-8. Interoperability Standards for CIGSS Infrastructure Function

Service	Standard	Availa-bility Date
Operating System Services	UNIX or Windows NT - see also Section 2.2.2.2.1.7 of JTA	1997
User Interface Services - Desktop - Display Environment	See Section 2.2.2.1.2 of JTA Common Desktop Environment or Windows NT X-Window and Motif or Windows NT	1997 1997
Data Management Services	See Section 2.2.2.1.3 of JTA - FIPS Pub 127-2: 1993, Database Language for RDBMS - Open Data Base Connectivity, ODBC 2.0	1997
Distributed Computing Services	Distributed Computing Environment of Open Software Foundation – based on IEEE POSIX standard PASC P1003.x - see Section 2.2.2.2.4 of JTA	1997
Document Interchange	See Section 2.2.2.1.4.1 of JTA Standard Generalized Markup Language (SGML) - ISO 8879: 1986 Hypertext Mark-up Language (HTML), Internet Version 2.0, RFC-1866: 1995 Document Interchange Formats - Table 2-1 of JTA	1997

Graphic Services	See Section 2.2.2.1.5 of JTA Graphical Kernel System (GKS) for 2-D graphics - ISO 7942 as profiled by FIPS Pub 120-1 (change notice 1): 1991 Programmers Hierarchical Interactive Graphics Systems (PHIGS) for 3-D graphics - ISO 9592: 1989, as profiled by FIPS Pub 153	1997
Graphics Data Interchange	See Section 2.2.2.1.4.2 of JTA Computer Graphics Metafile (CGM) - FIPS Pub 128-1: 1993 JPEG File Interchange Format (JFIF), Version 1.02, encoded using the ISO 10918-1: 1994, JPEG algorithm	1997
Security Services	See Section 6.0 of JTA	1997
Application Support Services - e-mail, directory services, file transfer, remote terminal, network management, network time, BOOTP, DHCP, WWW services, connectionless data transfer	See Section 3.2.1.1.1 in JTA, pages 3-2 to 3-4	1997
CIGSS LAN	Imagery LAN see Sections 3.2.2.2.5 & 3.2.3.3 of JTA Data LAN - Ethernet See Section 3.2.2.2.1 of JTA	1997 1997
DoD Data Model	See Section 4.2.2 of JTA - DoD Manual 8320.1-M-1, DoD Data Standardization Procedures, FIPS Pub 184, IDEF1X, December 1993	1997
DoD Data Definitions	See Section 4.2.3 of JTA - DoD Manual 8320.1-M-1, Defense Data Dictionary System (DDDS)	1997
Message Format	US Message Text Format (USMTF) - MIL-STD-6040. See Section 4.2.4.2.2 of JTA.	1997
Style Guides - DoD Human-Computer Interface - Domain-level	 DoD HCI Style Guide, TAFIM Version 2.0, Vol. 8, 30 September, 1994 See Section 5.2.2.2 of JTA User Interface Specification for the DII, June 1996	 1997 1997

3.9 CIGSS Management

The Management Function in this Handbook has been defined to highlight the need for integrated and coordinated management of the CIGSS functions to provide efficient use of the CIGSS resources and responsive service to internal and external users. The Management Function integrates and provides visibility to management activities traditionally occurring at the other functions and core components. The CIGSS Functions provide visibility at the architectural level to the need for integrated management. However, the Management Function can be implemented in a distributed fashion. It is also permissible to reallocate a management subfunction to another function for implementation. For example, the Exploitation Management subfunction (Section 3.1.9.4) is allocated to the Exploitation Function (Section 3.1.4) and is implemented in the IESS. DARO is proceeding with the definition of the CIGSS System Manager as another core component. A number of the management subfunctions will be allocated to the CIGSS System Manager. In the sections describing individual management subfunctions (sections 3.1.9.1 through 3.1.9.8), all management subfunctions have been assigned to the CIGSS System Manager except for Exploitation Management (allocated to IESS), and Archive Management (allocated to IPL).

The key responsibility of the management function is to control all CIGSS resources, operations, and activities in order to effectively respond to user needs. This function receives tasking from RMS, ATO, or JCMT and plans and prioritizes the activities of all the other functions necessary to satisfy the user requirements. This function must produce flexibility in scheduling of CIGSS operations, in response to dynamic changes in user requirements, and apply advanced scheduling algorithms to maximize the CIGSS throughput. This function must also maintain timely knowledge of the completion status of all elementary operations that have been scheduled for each image. Hence, it receives status data from all other functions of CIGSS and interfaces with external systems (RMS and USIGS) for receiving tasking and reporting completion status with respect to requirements. RMS controls the image collection and product dissemination requirements, while USIGS Integrated Management controls the exploitation and dissemination resources across the USIGS.

The Management Function is also responsible for responding to users on the status of their imagery requests. To provide “assured delivery” quality of service, the CIGSS Management Function should provide the users periodic reports of the status of in-process imagery operations related to their requests.

At the present time, there are no CIGSS management standards. A CIGSS will operate under the directives of the local commander. Different management approaches between the Services and individual commanders will likely create interoperability problems, since the overall management function has significant interfaces with RMS, USIGS, and the users. Reporting formats of image requests’ status to the users should be standardized under RMS documentation. It is also expected that NIMA will develop standards or directives for executing the Management Function under the USIGS Integrated Management initiative.

The schedules of operations on images will be exchanged between functions within a CIGSS. If these schedules are to be used by entities outside a CIGSS, they would have to be standardized. The interoperability objective of having various GSS share processing, archiving, and exploitation resources requires the exchange of image operation plans; and these would have to be standardized.

3.9.1 Mission Planning Management

This function responds to RMS collection requirements, to cross-cueing information, and to local commander directives to prioritize and schedule the activities of the Mission Planning Function. This function is assigned to the CIGSS System Manager.

3.9.2 Input of Sensor Data Management

This function controls the reception of sensor data from a number of sources in terms of priorities and schedules. This function is assigned to the CIGSS System Manager.

3.9.3 Schedule/Control of Processing Operations

This function schedules and controls the image processing operations at the CIGSS. This function is assigned to the CIGSS System Manager.

3.9.4 Exploitation Management

This function responds to RMS, JCMT, or ATO exploitation requirements, USIGS, and local commander directives to develop exploitation plans and schedules. This function is assigned to IESS.

3.9.5 Archive Management

The Archive Management function controls the operations of the IPL. Its primary responsibility is to control which image data (complex imagery, DMA maps, MTI data) and products are stored in the IPL and for how long. Since primary images require assignments of large storage increments per image, only a limited number of primary images can be stored in the CIGSS IPL. Since CIGSS is a deployable facility, the IPL image storage is limited and sized to be a revolving archive. Primary images that have already been exploited and are no longer of immediate interest may be moved out of the CIGSS IPL to a central storage library under USIGS direction. Also, some primary images may be moved out of the IPL shortly after their processing has been completed, so their exploitation can take place in another exploitation site.

The Archive Management function also controls which secondary images and exploitation products are stored in the IPL and their time periods of storage in the IPL.

Secondary images can be stored for longer periods than primary images, while exploitation reports may be stored indefinitely.

The Archive Management function responds to directives on storage of imagery and products from the command controlling CIGSS and the USIGS Integrated Management. To resolve conflicts in direction from two tasking authorities, it may be necessary to partition the storage capacity of the IPL between the needs of the local commander and the need for effectively supporting a larger military contingency by USIGS. It is expected the IPL will be partitioned into a public library open to external users and a private library restricted for the use of internal users.

The Archive Management function plans and schedules dynamically the IPL storage use based on the processing and exploitation plans developed by the Processing Management and Exploitation Management Functions, respectively. This function is assigned to IPL.

3.9.6 Dissemination Management

The Dissemination Management function deals with the prioritization and scheduling of the dissemination of primary and secondary imagery and exploitation products and controls the operations of the IMINT Dissemination function. This management function operates cooperatively with the other management functions which control the scheduling of processing, exploitation, and archiving of primary and secondary imagery and exploitation products. This function receives status information from the other management functions on the completion of scheduled operations per image and uses this information to update the schedules for deliveries of products. This function is assigned to the CIGSS System Manager.

3.9.7 External Communications Management

This function manages the operations of the External Communications function. It provides coordinated schedules to the Dissemination and External Communications functions. The purpose of this management function is to anticipate data traffic levels through the External Communications function and to take preemptive action to eliminate communications overloads that will cause delays in high-priority traffic. This function is assigned to the CIGSS System Manager.

3.9.8 CIGSS Resources Management

In addition to managing the operations of the CIGSS functions, the CIGSS resources including the infrastructure must be effectively managed. Attention to maintaining adequate levels of consumable items and spare parts, in conjunction with scheduled maintenance and software upgrades, should attempt to reduce disruptive system or component failures. Statistics on the workloads and performance of CIGSS components should be used to plan incremental expansion of CIGSS to handle larger workloads. This function is assigned to the CIGSS System Manager.

4. INDEPENDENT VERIFICATION PROCESS

This section provides an overview of the verification process that will be implemented to ascertain the compliance of GSS with the CIGSS standards identified in this Handbook. This section is excerpted from DARO's CIGSS Test and Evaluation Strategy (CTES). The details of the verification process will be defined in the CIGSS Overarching Test and Evaluation Plan (OTEP). This section focuses on verification of compliance to standards. However, OTEP will include the verification of compliance with the CIGSS architectural constraints and the Reference Model.

The intent of the verification process is that an appropriate level of testing be standardized and independent to ensure compliance with the CIGSS standards and the Reference Model. The meaning of compliance has to be well understood in terms of tests and procedures that have been accepted as standard across DoD. Furthermore, the verification authority needs to be recognized as qualified to conduct the verification tests and independent of the GSS developers. DARO intends to use the Joint Interoperability Test Command (JITC) to conduct the independent verification testing. The role of JITC is highlighted in this section and will be defined in detail in the OTEP.

The main objective of the CTES is that the OTEP provides a coherent and integrated master plan for all T&E activities necessary to verify that GSS have over time achieved compliance to standards and interoperability with each other and with interfacing systems. Much of the testing will be accomplished by the individual POs managing the migration of ground systems to the CIGSS Reference Model. The OTEP will not duplicate such T&E activities that have already been planned and funded, but will provide visibility and DARO management oversight into the T&E activities planned and executed by the service PMOs. Another objective of CTES is to uncover potential needs for additional T&E activities beyond those already planned. Finally, another objective is to monitor the T&E activities over time and to evaluate the viability and status of the migration plans for achieving the interoperability and modularity objectives.

The verification concept is described in section 4.1. Section 4.2 describes the Developmental Test and Evaluation approach. Section 4.3 describes the Operational Test and Evaluation approach. Section 4.4 defines the roles and responsibilities of the pertinent organizations expected to participate in the conduct of the T&E activities.

4.1 Verification Process Overview

The OTEP is expected to accomplish the following:

a. Integrate the T&E plans of the individual PMOs into annexes. It will also provide procedures for the review of T&E activities and the roles and responsibilities for verification and acceptance of T&E results by the appropriate organizations.

b. Define the T&E criteria for interoperability and modularity compliance to the CIGSS standards, and the Reference Model.

c. Provide a milestone schedule for the major T&E milestones of the ground systems for achieving CIGSS compliance. These milestones will be negotiated by the respective PMOs and the CMWG. A more detailed master schedule will be maintained showing all CIGSS related T&E activities.

The CTES concept is for the PMOs to conduct all T&E activities on their respective ground systems that are necessary to demonstrate CIGSS compliance. The PMOs will design such T&E activities according to criteria defined in the OTEP. Detailed descriptions of each T&E activity that has been planned will be provided by the respective PMO and will be included in a specific annex of the OTEP that describes all T&E activities planned by that PMO. The CIGSS Testbed may be used by the PMOs for the purpose of conducting tests to demonstrate CIGSS compliance.

GSS from different PMOs must be interoperable at dates specified by the T&E Master Schedule which will be included in the OTEP. Initial interoperability tests will be conducted jointly by the appropriate PMOs. Independent and formal verification of interoperability will later be conducted by the JTIC.

As a GSS system is being integrated from separate ground equipment, the responsible PMO will conduct functionality tests to demonstrate compliance to the CIGSS standards (addressed in this volume) for the CIGSS functions included in the GSS and interface standards for the special functions that are also included in the GSS. These functionality tests will be monitored by CMWG, DARO, JTIC and possibly representatives from GSS user organizations.

The interfaces of GSS to external systems like A3I and GCCS must meet established standards. The PMOs will be responsible for testing their systems against the interface standards. Independent and formal verification of interoperability with external systems will later be conducted by the JTIC.

DARO will provide system engineering and management oversight to ensure that all T&E activities fit into a coherent and integrated plan to achieve compliance to standards and interoperability for all ground systems and the CIGSS interfaces to external systems.

The CMWG will review T&E activities and will provide engineering implementation support. The CMWG will advise DARO on interoperability issues and on the definition of T&E criteria, while the CSWG will have oversight of the CIGSS standards.

4.2 Developmental Test and Evaluation

There are six types of developmental T&E activities:

a. Ground equipment tests for compliance to CIGSS standards

b. Functional verification/acceptance

c. Integration tests

d. Technical interoperability tests between different GSS and between GSS and interfacing systems like GCCS

e. Compatibility, interoperability, and integration certification

f. Security accreditation

(Further details on this section will be available in future drafts of Volume I.)

4.3 Operational Test and Evaluation

(The content of this section will be available in future drafts of Volume I.)

4.4 Roles and Responsibilities

4.4.1 GSS Program Management Offices

PMOs are responsible for all T&E activities within the development contracts they manage. The PMOs are responsible for developing the T&E plans for the ground equipment they develop or modify under contracts with vendors. The PMOs will submit their T&E plans to DARO for review, comment and approval. Approved T&E plans for specific systems will be incorporated into the OTEP as annexes.

The PMO T&E plans shall identify all the T&E activities to verify (1) compliance with the CIGSS standards, (2) interoperability with other ground equipment, (3) functionality tests of integrated GSS, and (4) interoperability of GSS with interfacing external systems such as GCCS. A milestone schedule will be provided in each PMO T&E plan. After completing each T&E activity, the PMO will submit a test report to DARO describing the test conducted and the results obtained and requesting certification for achieving specific T&E milestones in the PMO's T&E plan. The T&E activities proposed by a PMO shall follow the T&E procedures and shall meet the criteria for compliance to standards defined in the OTEP. Also, GSS functional tests and interface tests to external systems shall comply with the provisions in the OTEP.

Each PMO shall also participate with other PMOs in joint interoperability tests, and in GSS tests with external systems, as specified in the OTEP.

The PMOs shall make maximum use of the CIGSS Test Bed for interoperability tests to insure that all ground equipment interoperate with the same system.

4.4.2 DARO

DARO shall maintain the OTEP as the master plan for achieving compliance and interoperability of the CIGSS compliant GSS. DARO shall be responsible for assuring that the aggregate of CIGSS OTEP activities shall meet the compliance and interoperability objectives. DARO shall review the PMO T&E plans for adequacy and completeness, and may request the conduct of additional tests as appropriate.

DARO shall have the option of monitoring scheduled T&E activities, and shall review the test reports produced by PMO's. DARO shall utilize the CMWG to review of all T&E results and to recommend certification for compliance to CIGSS standards and the Reference Model. The CMWG will maintain the certification documents and copies of the supporting test result documents.

4.4.3 CMWG

The CMWG will review planned T&E activities and will provide engineering implementation support on interoperability and standards issues. It shall advise DARO on the efficacy and adequacy of the proposed testing and on testing criteria. The CMWG shall also monitor the T&E activities and advise DARO on the evidence that specific test results verify compliance to specific standards.

4.4.4 JITC

The Joint Interoperability Test Command shall be in charge for all formal interoperability tests (to be identified in the OTEP) as requiring an independent test authority. The design of such tests shall be developed by IITC and reviewed by DARO and the PMOs. The proposed tests may be modified to insure objectivity and to derive unambiguous results. The PMO's are expected to support such tests at the discretion of JITC, which shall have the option of using its own test personnel in part or totally.

APPENDIX A

DOCUMENT REFERENCES

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APPENDIX B

ACRONYMS AND DEFINITIONS

A

A3I	Accelerated Architecture Acquisition Initiative
A&T	Acquisition and Technology
AFMMS	Air Force Mission Management System
AFMSS	Air Force Mission Support System
ANSI	American National Standards Institute
API	Application Program Interface
ASD	Assistant Secretary of Defense
ATARS	Advanced Tactical Air Reconnaissance System
ATM	Asynchronous Transfer Mode

C

C3I	Command, Control, Communications, and Intelligence
C4I	Command, Control, Communications, Computers, and Intelligence
CAF	Catalog Access Facility
CARS	Contingency Airborne Reconnaissance System
CDL	Common Data Link
CFS	Center for Standards
CHBDL-ST	Common High Bandwidth Data Link Surface Terminal
CIGSS	Common Imagery Ground/Surface System
CIIF	Common Imagery Interoperability Facilities
CIIP	Common Imagery Interoperability Profile
CIO	Central Imagery Office
CIP	Common Imagery Processor
COE	Common Operating Environment
CONUS	Continental United States
COTS	Commercial Off-the-Shelf
CSM	CIGSS System Manager
CSWG	CIGSS Standards Working Group

D

DARO	Defense Airborne Reconnaissance Office
DCRSI	Digital Cassette Recording System Improved
DII	Defense Information Infrastructure
DISA	Defense Information Systems Agency
DISN	Defense Information System Network

DoD	Department of Defense

E

EEI	Essential Elements of Information
ETRAC	Enhanced TRAC (Tactical Radar Correlator)

F

FDDI	Fiber-Distributed Data Interface
FGDC	Federal Geographic Data Committee
FTP	File Transfer Protocol

G

GBS	Global Broadcasting System
GCCS	Global Command and Control System
GOTS	Government Off-the-Shelf
GSS	Ground/Surface System(s)

H

HiPPI	High Performance Parallel Interface
HMMWV	High Mobility Multipurpose Wheeled Vehicle

I

IA	Imagery Analyst
IAF	Image Access Facility
IASS	Image Access Services Specification
IDF	Imagery Dissemination Facility
IDL	Interface Definition Language
IESS	Imagery Exploitation Support System
IMINT	Imagery Intelligence
INT	Intelligences
IP	Internet Protocol
IPL	Image Product Library
IPT	Integrated Product Team

J

JORD	Joint Operational Requirements Document
JSIPS	Joint Service Imagery Processing System
JSIPS-N	Joint Service Imagery Processing System - Navy
JTA	Joint Technical Architecture

JTF	Joint Task Force
JTIC	Joint Interoperability Test Center

L

LAN	Local Area Network
LOS	Line of Sight
LRC	Lesser Regional Conflict

M

MIES	Modernized Imagery Exploitation System
MIL-STD	Military Standard
MRC	Major Regional Conflict
MSI	Multi-Spectral Imagery
MTI	Moving Target Indicator

N

NIMA	National Imagery and Mapping Agency
NIS	National Input Segment
NITF	National Imagery Transmission Format
NRO	National Reconnaissance Office

O

OOTW	Operations Other Than War

P

P3I	Preprogrammed Product Improvement
P&NF	Profile and Notification Facility
PMO	Program Management Office

R

RMS	Requirements Management System
RULER	A software application for doing mensuration and related analysis functions

S

SDE	Support Data Extension (to NITF 2.0)
SID	Secondary Imagery Dissemination
SIGINT	Signals Intelligence

SNMP	Simple Network Management Protocol
SONET	Synchronous Optical Network
SPIA	(USIS) Standards Profile for Imagery Archives

T

TAFIM	(DoD) Technical Architecture Framework for Information Management
TAMPS	Tactical Aircraft Mission Planning System
TCP	Transmission Control Protocol
TEG	Tactical Exploitation Group
TEMP	Test and Evaluation Master Plan
TIGDL	Tactical Interoperable Ground Data Link
TSM	Tactical System Manager

U

UAV	Unmanned Aerial Vehicle
UDD	User Defined Device
USD	Under Secretary of Defense
USIGS	United States Imagery and Geospatial Systems
USIS	United States Imagery System
USMTF	Uniform Standard Message Text Format